# MINERAL LAND CLASSIFICATION OF THE ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP, AND STEWART VALLEY 15-MINUTE QUADRANGLES AND HIGH PEAK 7.5-MINUTE QUADRANGLE, INYO COUNTY, CALIFORNIA

**1993**

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CALIFORNIA DEPARTMENT OF CONSERVATION

Division of
Mines and Geology

## SPECIAL REPORT 167

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# MINERAL LAND CLASSIFICATION OF THE ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP, AND STEWART VALLEY 15-MINUTE QUADRANGLES AND HIGH PEAK 7.5 MINUTE QUADRANGLE INYO COUNTY, CALIFORNIA

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By

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# PREFACE

This Special Report is one of a series of mineral land classification studies being conducted in the eastern Mojave desert region by the California Division of Mines and Geology, under the authority of the Surface Mining and Reclamation Act of 1975 (SMARA). The classification information is provided to the State Mining and Geology Board for transmittal to local governments who regulate land use in this region. SMARA was enacted by the State Legislature to assure mineral resource conservation and adequate mined land reclamation. The undertaking is of importance in economic geology because it deals with specific mineral resource conservation issues in areas of intense land-use competition. Results of these studies, therefore, should be of considerable interest not only to local land-use regulators, but also to other government agencies, local property owners, and the mining industry.

# EXECUTIVE SUMMARY

The California Surface Mining and Reclamation Act of 1975 requires the State Geologist to classify land, according to the presence, absence, or likely occurrence of significant mineral deposits in certain areas of the State subject to urban expansion or other irreversible land uses incompatible with mining. The primary objective of mineral land classification is to ensure that the mineral potential of land is recognized and considered before land-use decisions which could preclude mining are made. Commitment of land to uses which preclude mining has been a major contributing factor to the increasing loss of significant mineral resources in California. This has happened because land-use planning decisions have been made with little, if any, knowledge of underlying deposits and the importance they hold in supplying the needs of our society.

Mineral land classification provides land-use regulators, local property owners, and the mining industry with scientific information regarding the nature, occurrence, and distribution of mineral deposits. The information is intended for collective use by these user groups in land use planning, mineral conservation, and mineral development.

With the concurrence of the State Mining and Geology Board, the State Geologist has initiated mineral land classification studies in the Mojave Desert Region of California. The Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, Ryan, Pahrump, and Stewart Valley 15-minute and High Peak 7.5-minute U.S. Geological Survey topographic quadrangles encompass approximately 760 square miles of land in the northern Mojave Desert Region and constitutes the study area. This report includes a geologic map of the area, Plate 1, and Mineral Land Classification maps that contain industrial mineral deposits, Plate 2, and mineral deposits of hydrothermal origin, Plate 3. The nature and distribution of these deposits closely relate to the geologic framework of the region. Three factors appear to have controlled mineralization within the study area; lithology, faulting and metasomatism. The mineral land classification reflects these relationships.

**Major findings of this study are:**

- The most significant mineral deposits which are known to exist within the study are those formed by hydrothermal processes from which the industrial minerals borates, zeolites, hectorite, and bentonite currently are being produced. Additionally, production of minor amounts of silver, lead, zinc, and copper ores has occurred in past years from small hydrothermal base-metal systems.

- Three areas have been classified MRZ-2a for borates. These are: (1) the Ryan area, MRZ-2a$^{(bo-1)}$, which encompasses the U.S. Borax Widow #3, Widow #7, Grand View, Lizzie V. Oakley, Upper and Lower Biddy McCarthy, and Played Out mine properties, and the southeastern extension of these properties. Proven reserves of borates in excess of 6 million tons have been delineated; (2) the Gerstley mine area, MRZ-2a$^{(bo-2)}$, which includes the Gerstley mine and the Gerstley II deposits containing in excess of 1,250,000 tons of borate reserves; and (3) the Maria deposit, MRZ-2a$^{(bo-3)}$, which contains in excess of 700,000 tons of proven borate reserves.

- The Ash Meadows zeolite deposit, MRZ-2a$^{(z-4)}$, has proven reserves of clinoptilolite in excess of 50 million tons and probably represents the largest known commercial deposit of zeolites in the United States. This property is under current production by Zeolites International.

- A deposit of hectorite, a lithium-bearing clay, currently being mined by Industrial Mineral Ventures, has been classified as MRZ-2a$^{(b-5)}$. Extensive proven reserves exist; however, data is considered proprietary.

- The R.T. Vanderbilt Company is currently producing a bentonitic clay from their Sidehill mine property, which has been classified MRZ-2a$^{(b-6)}$. Measured reserves are minimal; however, indicated reserves are extensive for the property.

- Another significant mineralized area, MRZ-2b$^{(bo-7)}$, encircles the Maria deposit, MRZ-2a$^{(bo-3)}$, and encompasses three properties, the Lila C., Terry, and Cone Hill claims which contain subeconomic or marginal borate reserves. It is highly probable that additional drilling at these properties would upgrade the classification to MRZ-2a.

- A broad arcuate-shaped zone, originating near Ryan and sweeping centrally across the study area, has been classified MRZ-3b$^{(bo-8)}$. This zone, which encompasses all known deposits of borates, in conjunction with the smaller Chicago Valley area, MRZ-3a$^{(bo-13)}$, delineates an area of favorable terrane for borate deposits.

- Three smaller areas, which comprise aureols of mineralization around mines producing the industrial minerals of zeolite, hectorite, and bentonite, have been classified MRZ-3a$^{(z,b,bo-9)}$, MRZ-3a$^{(b-10)}$, and MRZ-3a$^{(b-11)}$ respectively.

- A large area within Greenwater Valley has been classified MRZ-3a$^{(h-1)}$, MRZ-3a$^{(h-2)}$, and MRZ-3b$^{(h-7)}$ as containing a favorable geologic environment for hydrothermally formed metallic deposits. This area encompasses the Greenwater mining district which was the site of a copper prospecting boom in 1905-1908. Widespread secondary copper mineralization, with associated gold and silver values, exists within a widespread system of barite veins which typically occur within rhyolitic intrusive rocks near their contact with Tertiary monzonitic rocks. Although historic copper production was negligible, geologic conditions suggest the possibility that a porphyry copper and/or disseminated silver-gold deposit may exist in the area.

- Zeolite, perlite, and pumice resources have been identified in volcanic rocks within the Greenwater Range, and carbonate resources have been delineated in the Nopah Range, Resting Spring Range and the southern part of the Funeral Mountains. Favorable terranes for the occurrence of these industrial mineral deposits have been classified MRZ-3a$^{(z-15)}$, MRZ-3a$^{(p-17)}$, MRZ-3a$^{(pu-18)}$, and MRZ-3a$^{(ls-14)}$.

- The area of Alkali Flat, classified MRZ-3a$^{(na, li, u-12)}$ for saline mineral supported limited production of salines, probably during the period, 1940 to 1960. Recent drilling by the U.S. Geological Survey detected anomalous amounts of lithium and uranium in calcareous playa sediments.

- Land-use competition in the study area has increased dramatically over the last 10 to 15 years, mainly as a result of Southern California growing and a very mobile population which has greatly accelerated land demand for a variety of purposes, many of which conflict with mining. An increasing awareness of the wilderness values of the land has resulted in the establishment of the National Wilderness system in which mining would be prohibited. As a consequence, the federal government and local lead agencies have found it necessary to develop plans establishing suitable areas for specific land use. In this regard, the Nopah Range, a large part of the Resting Spring Range, the southern part of the Funeral Mountains and the southern part of the Black Mountains, located in the study area, are currently being considered for inclusion into the National Wilderness System. Information gathered for the mineral land classification of the Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, Ryan, Pahrump, and Stewart Valley 15-minute quadrangles and High Peak 7.5-minute quadrangle has revealed that favorable terranes for significant mineral deposits exist within these proposed wilderness areas. These deposits have been ranked below in order of potential economic importance:

  The proposed Resting Spring Range WSA encompasses an area between Highway 127 and the range front that is considered by industry sources to have a high potential for possessing structural basins with borate mineralization.

  The Nopah Range WSA, Resting Spring Range WSA and Funeral Mountains WSA all contain extensive resources of carbonate and siliceous rock.

  The Resting Spring range contains known, although minor, deposits of hydrothermal silver-lead-zinc mineralization and a possible stratabound copper deposit.

The study area should be periodically reevaluated and the classification maps updated as necessary in order to take into account any new discoveries of mineral deposits, as well as allowing for changes in technology, economic conditions, and geologic concepts that would have a bearing on assessing the significance of mineral resources that may be present. All of the areas classified as MRZ-3a are favorable target areas for mineral exploration. Consequently, we can expect that mineral discoveries will be made as a result of further exploration within some of them. The MRZ-3a areas should be given special consideration at the time the classification information is incorporated in the general plans.

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# PART I – MINERAL LAND CLASSIFICATION

## INTRODUCTION

### Background And Purpose

The primary objective of mineral land classification is to assure that mineral potential and its significance is recognized and considered before land-use decisions that could preclude mining are made. The availability of mineral resources is vital to our society. Yet for most types of minerals, economic deposits are rare, isolated occurrences which are difficult to discover. As a consequence, these circumstances limit the options available for locating those rare sites that have been discovered to contain minerals. Access to terrane for purposes of mineral exploration and mine development is now difficult because California is also faced with growing land-use competition. Local planning agencies are faced with increasingly difficult land-use decisions as needs for the land for a variety of purposes must be made. If we are to continue to be able to supply mineral raw material needs for California, it will be essential that efforts continue to identify areas of significant mineral resource potential for use in planning .

In 1975, the State took a major and innovative step towards resolving the conflict between mining and competing land uses by enacting the Surface Mining and Reclamation Act (SMARA). This law provides for reclaiming mined lands, and classifying lands within the State according to the presence, absence, or likely occurrence of any significant mineral resources. The Mineral Land Classification information is provided by the State Geologist to the State Mining and Geology Board who will transmit it to local government land-use regulators for incorporation in their general plans.

### Use Of This Report

This report is intended to provide meaningful information to three basic user groups: local government, property owners, and the mining industry. As a consequence, various sections in the text may prove more meaningful to some readers than others while other sections will be pertinent to all readers.

It is important that the reader gain an understanding of the way in which Mineral Resource Zones (MRZ's) are defined and applied to mineral land classification. Zones are described in the "Mineral Land Classification" section of the text. Special attention should be given to:

(1) the classification system for mineral resource zones developed by the Division of Mines and Geology (DMG) and the relationship of this system to a similar approach by the U.S. Bureau of Mines and the U.S. Geological Survey (1980);

(2) the graphical representation of the resource classification system (California Mineral Classification Diagram; Figure 3); and

(3) associated nomenclature used to communicate mineral resource information (see definitions for terminology used in Figure 3).

## CLASSIFICATION PROCEDURES

The California Desert Conservation Area is one of several geographic regions in California to be selected for mineral land classification studies (Figure 1). Other regions of the State subject to classification include major metropolitan centers and the western slope of the Sierra Nevada Range between Mariposa and Lake Almanor.

### Data Gathering And Assessment

This study covers the southeast quarter of the Death Valley 1° x 2° sheet, which encompasses all or portions of seven 15-minute quadrangles and one 7.5-minute quadrangle as shown on Figure 2.

The study included geologic and mining-related literature research, compilation of geologic maps and plotting of reported mines and prospects using information obtained from the U.S. Bureau of Mines, publications of the Division of Mines and Geology, and various other sources.

The study involved a field work phase which included a site investigation of most of the known mines and mineral sites within the study area, selected sampling of rocks for analyses of their gold and silver content by fire assay, collecting of several minerals for analyses by X-ray spectrometry analysis, and analyses of aerial photographs. Field observations and literature descriptions of mineral occurrences were studied closely in an effort to identify the geologic factors which control or influence mineralization.

The field and analytical information were then integrated and evaluated in order to serve as the basis for assigning mineral resource zones to areas in accordance with mineral land classification guidelines adopted by the State Mining and Geology Board. A geologic map (scale 1:62,500) and a series of mineral land classification maps (scale 1:62,500) were prepared and are included in this report (Plates 1-3). All three maps show mine and prospect localities.

### The California Mineral Land Classification System

Land throughout the Death Valley 1° x 2° sheet was classified into Mineral Resource Zones (MRZ's) with respect to the presence, absence, or likely occurrence of mineral deposits according to guidelines adopted by the California State Mining and Geology Board (1979, p. 23).

The State Geologist, in consultation with the Mining and Geology Board, has adapted the MRZ nomenclature presented in the above guidelines to generally accepted terminology for consideration of mineral resources and reserves used in the California Mineral Land Classification System (Figure 3). The California Mineral Land Classification Diagram is an adaptation which represents an evolution of a classification system developed by the U.S. Bureau of Mines and the U.S. Geological Survey (1980), which is a graphical representation of what has become a standard reference to present the relationship between the knowledge of mineral deposits and their economic


Figure 1. Map of California showing urban and nonurban areas of the State subject to mineral land classification.

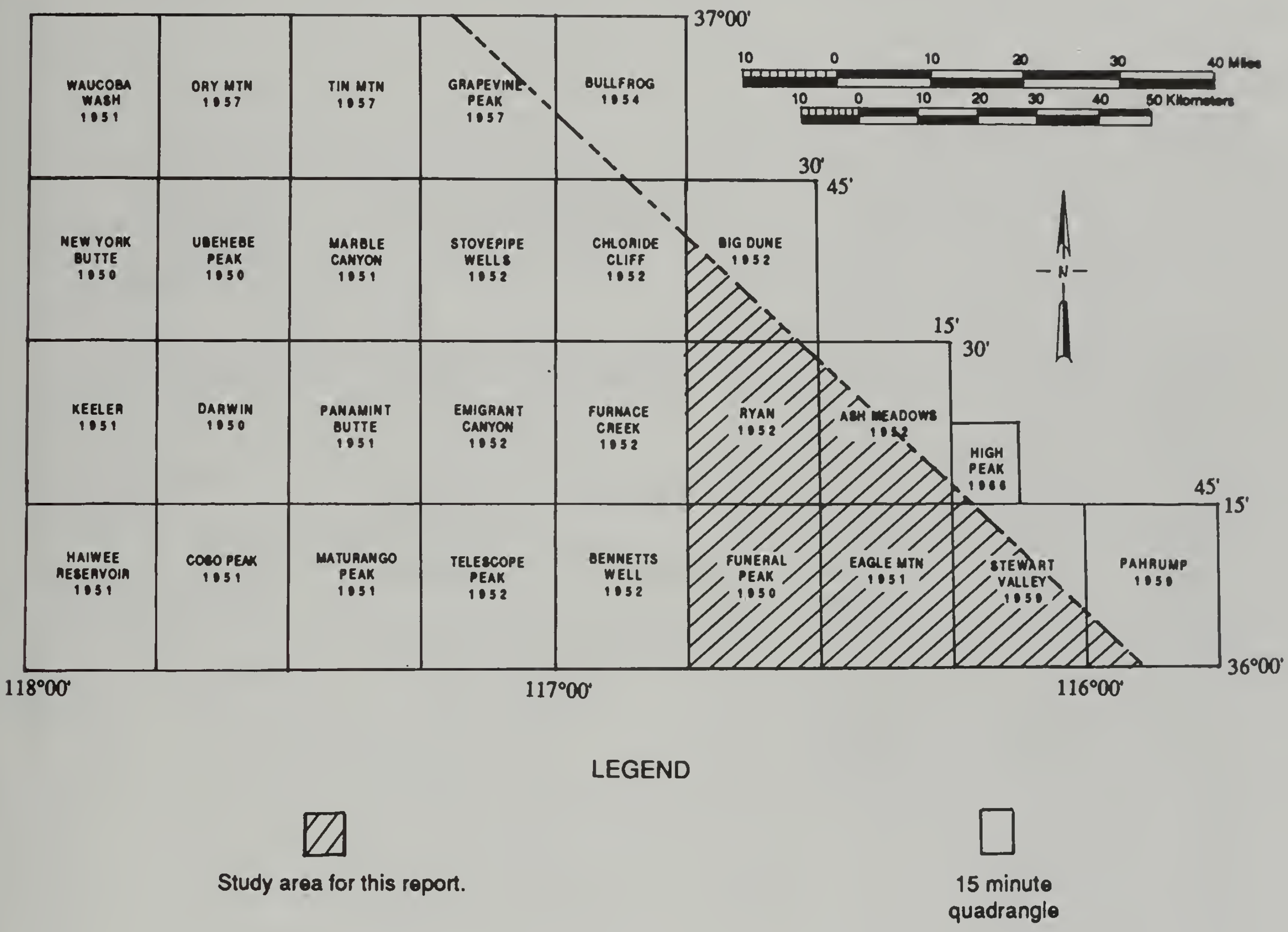


Figure 2. Index map of 15-minute quadrangles covering the Death Valley SMARA study area.

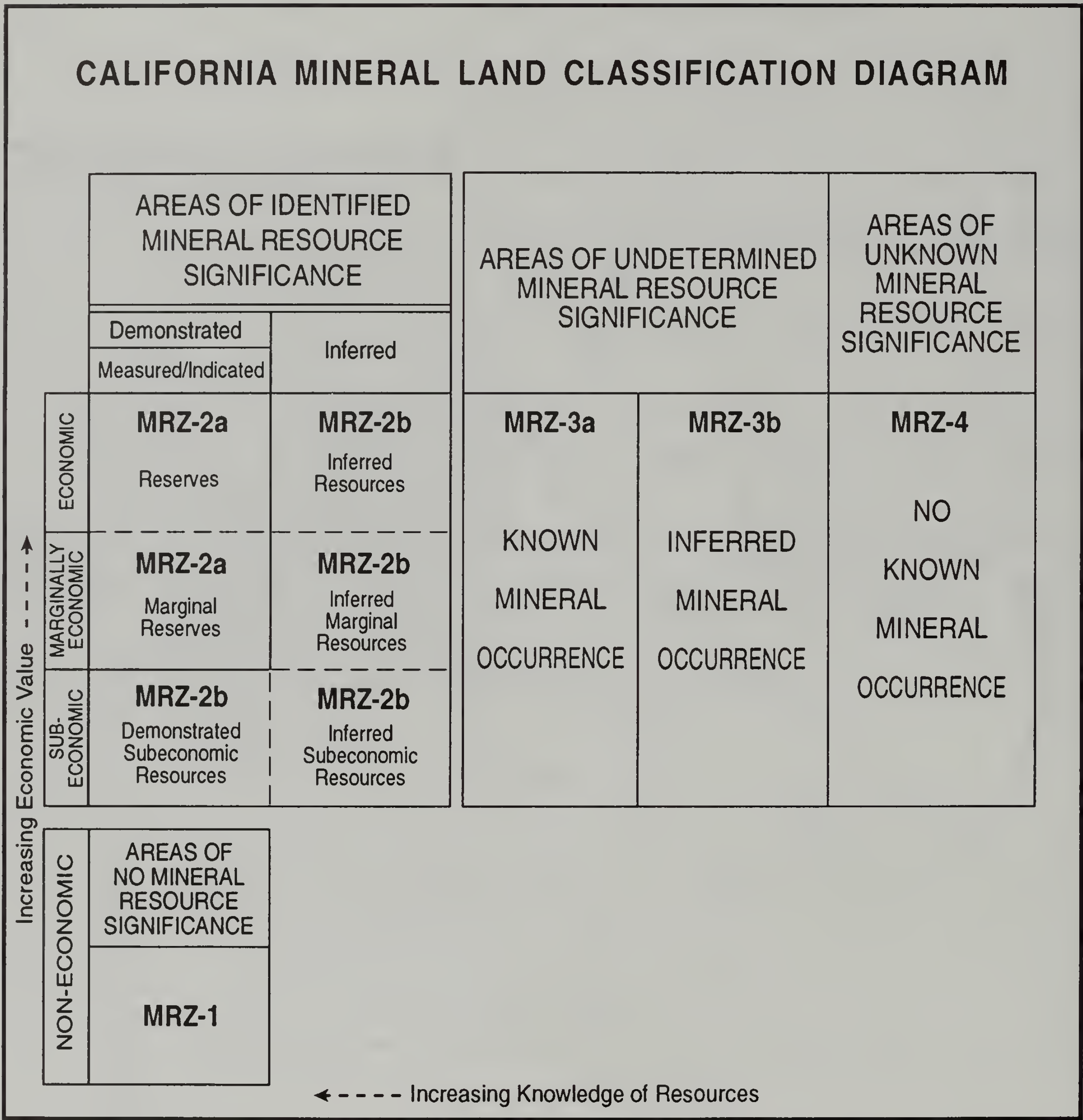


Figure 3. California Mineral Land Classification Diagram: Diagrammatic relationship of mineral resource zone categories to the resource/reserve classification system. See Appendix A for explanation of nomenclature.

characteristics (grade and size). The nomenclature used with the California Mineral Land Classification Diagram (see Appendix A) is important in communicating mineral potential information in activities such as mineral land classification, and usage of these terms are incorporated into the criteria developed for assigning mineral resource zones. Note that the horizontal axis of the California Mineral Land Classification Diagram represents degree of knowledge about mineral deposits while the vertical axis represents economic characteristics. The two major divisions on the diagram are "Identified Resources" and "Undiscovered Resources". The division between these two major "knowledge" categories also marks the division between areas classified MRZ-2 and MRZ-3; wherein land classified MRZ-2 represents areas that contain *identified* mineral resources and land classified MRZ-3 represents areas in which *undiscovered* mineral resources are likely to occur.

### MRZ Categories - Non-Urban Studies

In order to communicate information concerning the metallic and industrial mineral potential of land subject for classification, the classification categories set forth in the guidelines of the State Mining and Geology Board have been adapted to the California Mineral Land Classification Diagram. These general adaptations are presented below:

**MRZ-1:** Areas where available geologic information indicates there is little likelihood for the presence of mineral resources.

**MRZ-2a:** Areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present. As shown on Figure 3, MRZ-2 is divided on the basis of both degree of knowledge and economic factors and MRZ-3 with respect to knowledge of economic characteristics of resources. Areas classified MRZ-2a contain discovered mineral deposits that represent either measured or indicated reserves as determined by such evidence as drilling records, sample analyses, surface exposure, and mine information. Land included in the MRZ-2a category is of prime importance because it contains known economic mineral deposits.

**MRZ-2b:** Areas underlain by mineral deposits where geologic information indicates that significant inferred resources are present. Areas classified MRZ-2b contain discovered deposits that represent either inferred reserves or deposits that are presently subeconomic as determined by limited sample analyses, exposure, and past mining history. Further exploration work and/or changes in technology or economics could result in upgrading areas classified MRZ-2b to MRZ-2a. The MRZ-2b designation is applied to areas where geologic evidence indicates there is a high likelihood that economic concentration of minerals are present.

**MRZ-3a:** Areas underlain by geologic settings within which undiscovered mineral resources similar to known deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Lands classified MRZ-3a represent areas in geologic settings which are favorable environments for the occurrence of specific mineral deposits. In the classification diagram, these lands are referred to as hypothetical resources. Further exploration work within these areas could result in the reclassification of specific locations into the MRZ-2a or MRZ-2b categories. MRZ-3a areas are considered to have a moderate potential for the discovery of economic mineral deposits.

**MRZ-3b:** Areas that may contain undiscovered mineral resources that occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential (speculative resources). Lands classified MRZ-3b represent areas in geologic settings which appear to be favorable environments for the occurrence of specific mineral deposits. In the California Mineral Land Classification Diagram, these are referred to as speculative resources. Further exploration work could result in the reclassification of all or part of these areas into the MRZ-3a category or specific localities into the MRZ-2a or MRZ-2b categories. MRZ-3b is applied to lands where geologic evidence leads to the conclusion that plausible economic mineral deposits are present.

**MRZ-4:** Areas where geologic information does not rule out either the presence or absence of mineral resources. MRZ-4 is applied to areas of unknown mineral potential that occur within a broader favorable terrane known to host economic mineral deposits.

Areas classified MRZ-1 (areas which are not likely to contain mineral deposits) and MRZ-4 (areas where available data do not preclude the presence or absence of mineral deposits) fall outside the California Mineral Land Classification Diagram (Figure 3). However, both classification categories are important factors in mineral potential land-use considerations.

## MINERAL RESOURCE ZONES

Mineral resources identified as a result of this study include industrial and hydrothermal metalliferous mineral deposits. The geologic and economic characteristics of resource zones in which deposits occur are summarized below (Tables 1 and 2) and are discussed in more detail in the "Mineral Resource Assessment" section of this report.

## Areas Classified For Industrial Mineral Deposits

Industrial mineral deposits (Appendix A) are of naturally-occurring earth materials that are of economic value, because of the physical and/or chemical characteristics which they possess. This category does not include metallic mineral deposits, gemstones, or fuels. Within the study area, deposits of industrial minerals are widely distributed and comprise resources of considerable economic importance. Deposits containing varying amounts of borates (Ryan area, Lila C. Mine, Maria, Terry, Gerstley Mine), bentonite (Sidehill Nine), hectorite (IMV Mine) and zeolites (Ash Meadows) are currently being mined. Limited past production has been recorded for saline operations at Alkali Flat, while deposits of carbonate rock, perlite, barite, and pumice have only been the subject of prospecting activity.

In order to better assess the economic significance of the industrial mineral deposits identified in this study, it would require extensive surface and subsurface sampling, and laboratory analyses of the samples. A tabulation of the geologic and economic characteristics of each of the industrial mineral resource zones is summarized in Table 1. A detailed description of them is provided in the "Mineral Land Classification" section of this report, and their geographic distribution is shown on Plate 2.

## Areas Classified For Hydrothermal Mineral Deposits

Hydrothermal mineral deposits (Appendix B) containing gold, silver, lead, zinc, and copper are widely distributed in the study area. However, in some of the areas, hydrothermal mineralization shows considerable continuity and, as a consequence, represent attractive targets where significant mineral resources may be present. Typically, these areas are identified by characteristic hydrothermal mineral assemblages that have been localized along structural breaks in the host rock or within open cavities in porous rock. In the course of this study, eight hydrothermal mineral resource areas were identified which are believed to represent favorable environments for the occurrence of gold, silver, lead, zinc, copper, and barite. These include: (1) a northwest-trending copper, silver, gold, and barite mineralized area in the Greenwater Valley area, (2) a northwest-trending zone of silver, lead, zinc deposits in the central Resting Spring Range, (3) an apparent stratabound copper deposit in the Shadow Mountain area, (4 and 5) a north-trending zone of copper, lead, silver mineralization along the northwestern Resting Spring Range, and (6) silver, lead, zinc mineralization in the northern Nopah Range.

The economic significances of the above-listed areas have not been established. Although most of the areas contain mines that have recorded only minor past production, they should be considered as attractive exploration targets which may have importance for future development. A tabulation of the geologic and economic characteristics of each area in which mineralization has been identified for the various mineral resource zones are summarized in Table 2. Detailed descriptions of the classified areas are provided in the "Mineral Land Classification" section of this report, and their geographic distribution is shown on Plate 3.

*TABLE 1. CHARACTERISTICS OF INDUSTRIAL MINERAL MRZ-AREAS*
*(Borates, clays, barite, silica)*

| | GEOLOGICAL FACTORS | | | | ECONOMIC FACTORS | | |
|---|---|---|---|---|---|---|---|
| AREA | Mineralogic, Chemical, or Phyisical Characteristics | Lithologic, Structural, Depositional, or Other Control of Deposits | Evidence of Mineralization is Present (Geophysical, Geochemical or Geological) | Density & Distribution of Known Mineralization (high, medium, low) | Current or Past Production Has Occurred | Measured, Indicated Inferred or Undiscovered Resources | REMARKS |
| MRZ-2a (bo-1) (Ryan Area) | Colemanite, ulexite, probertite | L, S Furnace Creek Fm. | Downdip extension of Furnace Creek Fm. under Funeral Fm. volcanics | High | Past production | Measured reserves in Widow #3, Widow #7, Grand View, Biddy McCarthy | Current drilling program by U.S. Borax to delineate additional reserves. |
| MRZ-2a (bo-2) (Gerstley Mine Area) | Colemanite, ulexite, probertite | L,S Gerstley Lake beds | Downdip extension of Gerstley Lake beds under Tertiary volcanics and alluvium | High | Current production | Measured reserves | Southeast downdip extension of the Gerstley Lake beds being drilled by U.S. Borax. |
| MRZ-2a (bo-3) (Maria Deposit) | Colemanite, ulexite, probertite | L, S Furnace Creek Fm. | | High | No production | Measured reserves | Deposit is blind, occurring at 700-900 ft depth, has been drilled and patented. |
| MRZ-2a (z-4) (Anaconda Zeolite Deposit) | Clinoptilolite | L, S | Hydrothermally altered Tertiary tuff beds | High | Current production | Measured reserves | Probably the largest known commercial deposit of clinoptilotite in the U.S. |
| MRZ-2a (b-5) (Sidehill Mine) | Bentonite | L, S Tertiary tuffaceous sediments | | High | Current production | Indicated reserves | Tertiary tuffs are well exposed along strike; downdip extension has not been explored. |
| MRZ-2a (b-5) (IMV Mine) | Clay (hectorite) | L, S | Quaternary lake sediments | Low | Current production | Measured reserves | Deposit has been grid drilled by IMV patent application filed with BLM. |
| MRZ-2a (b-6) (Lila C. Mine Area) | Colemanite, ulexite, probertite | L, S Furnace Creek Fm. | Extension of Furnace Creek Fm. into area covered by alluvium | Low | Past production | Minor measured reserves, indicated resources | Surficial exposures of colemanite at Terry and Cone Hill claims. Lila C. downdip extensions have not been drilled. |
| MRZ-3a (z, b-8) (Ash Meadows Area) | Clinoptilolite, bentonite, borates? | L, S | Altered Tertiary tuff beds, geochemical | High | No production | Moderate potential for economic deposits | Large areal distribution of altered tuff beds. Anaconda drilling program has revealed zeolites and bentonite occurrences under alluvial cover. Possible existence of Furnace Creek Fm. in the area. |
| MRZ-3a (b-9) (Eastern Funeral Mountains) | Bentonite | L, S | Altered tuff beds | High | No production | Moderate potential for undiscovered resources | Surficial deposits of bentonite, minor exploration trenching performed but no drilling. |

*TABLE 1. CHARACTERISTICS OF INDUSTRIAL MINERAL MRZ-AREAS*
*(Borates, clays, barite, silica)*

| AREA | GEOLOGICAL FACTORS | | | | ECONOMIC FACTORS | | REMARKS |
|---|---|---|---|---|---|---|---|
| | Mineralogic, Chemical, or Phyisical Characteristics | Lithologic, Structural, Depositional, or Other Control of Deposits | Evidence of Mineralization is Present (Geophysical, Geochemical or Geological) | Density & Distribution of Known Mineralization (high, medium, low) | Current or Past Production Has Occurred | Measured, Indicated Inferred or Undiscovered Resources | |
| MRZ-3a (na, l-10) (Alkali Flat) | Sodium compounds, minor lithium and uranium | Depositional | Playa deposits | High | Possible past production of salines | Inferred | U.S.G.S. drilling program in 1970's detected anomalous concentrations of lithium and uranium in calcareous muds. |
| MRZ-3a (ls, si-11) (Nopah & Resting Spring Ranges) | Limestone and quartzite | Marine sedimentary sequence | Paleozoic carbonate & siliceous rocks | High | No production | Moderate potential for economic resources | Carbonate & siliceous rocks have impurities that may affect commercial applications. |
| MRZ-3a (z-12) (Eastern Greenwater Range) | Clinoptilotite | Localized hydrothermal alteration of tuffs | Altered Tertiary tuffs | Medium | No production | Moderate potential for economic resources | Upper pyroclastic member of the Artist Drive Formation has been zeolitized. |
| MRZ-3a (ba-13) (Greenwater Valley Area) | Barite | Barite veins localized in Tertiary volcanic rocks | Geochemical anomalies | High | No production | Low potential for economic resources | Barite veins are widely distributed; however steep dips and narrow widths probably preclude commercial development. |
| MRZ-3a (s-14) (Eagle Mountain Area) | Decorative Stone | | | Low | No production | Low potential for commercial resources | |
| MRZ-3a (pu-15) (Greenwater Canyon Area) | Pumice | Tuff-breccia member of the Greenwater volcanics | | Low | No production | Low potential for economic resources | |
| MRZ-3b (bo-16) (Eastern Greenwater Range-Amargosa Valley) | Colemanite, ulexite, and probertite | L, S Furnace Creek Fm. | Seismic data indicate basinal structures | High | No production | High potential for undiscovered resources | Zone encompasses all known borate deposits. |
| MRZ-3b (bo-17) (Chicago Valley Area) | Colemanite, ulexite, and probertite | L, S Gerstley Lake beds | Sedimentary basin with Tertiary sediments | Low | No production | Moderate potential for undiscovered resources | Inconclusive drilling results by U.S. Borax within the basin. |
| MRZ-3b (bo-18) (Franklin Well Area) | Hectorite | L, D | Quaternary Lake sediments adjacent to hot springs centers | Low | No production | Moderate potential for undiscovered resources | |
| MRZ-3b (na, bo-19) (Stewart-Pahrump Valley) | Sodium compounds | L, S, D | Sedimentary basin | Low | No production | Low potential for undiscovered resources | |
| MRZ-3b (p-20) (Greenwater Range) | Perlite | L | Tertiary vitrophyric rocks | Low | No production | | Rocks containing perlitic structures are flows; thus commercial applicability of this material is questionable. |

Letters denote the following: Industrial minerals – b=bentonite (clay), ba=barite, bo=borate, l=lithium, ls=limestone, na=sodium, p=perlite, pu=pumice, s=stone, si=silica, z=zeolites

Ore controls – L=lithologic, S=structural, D=depositional

*TABLE 2. CHARACTERISTICS OF HYDROTHERMAL MRZ-AREAS*
*(Gold, silver, copper, lead, zinc)*

| AREA | GEOLOGICAL FACTORS: Characteristic Hydrothermal Minerals and Alteration Affects are Present | GEOLOGICAL FACTORS: Structural Control of Mineralization is Apparent | GEOLOGICAL FACTORS: Evidence of Mineralization is Present (Geophysical, Geochemical or Geological) | GEOLOGICAL FACTORS: Density & Distribution of Known Mineralization (high, medium, low) | ECONOMIC FACTORS: Current or Past Production Has Occurred | ECONOMIC FACTORS: Measured, Indicated Inferred or Undiscovered Resources | REMARKS |
|---|---|---|---|---|---|---|---|
| MRZ-3a (h-1) (Greenwater Mining District) | m,chr, a ba, hm, q, Hf | N30-65E & N30-70W vein systems in rhyolitic intrusive rocks near contact with Tertiary monzonitic rocks | | High | Very minor past production | Moderate potential for undiscovered resources | Site of copper boom in 1905-08. Numerous deep shafts (up to 1400') were sunk but only minor sulfide ore found at depth. |
| MRZ-3a (h-2) (Eastern Greenwater Valley) | m, chr, a, ba, hm, q, s, Hf | Vein system in Tertiary extrusive rocks with disseminated barite | Geochemical anomalies in the area | Medium | Not known but doubtful if any | Moderate potential for undiscovered resources | Small pits, cuts & shallow shafts (max 90') on secondary copper mineralization associated with barite veins. |
| MRZ-3a (h-3) (Baxter Mine Area) | a, m, gl, hm, sph, s, ce, chr, bo, c, p, Ha, Hsi | NW trending zone over 9000' long | Hydrothermal alteration zone (hemitization) on Landsat imagery | High | Past production | Moderate potential for undiscovered resources | Numerous pits, adits and inclines. Mine yielded 43 tons of ore, 1920-27, which contained 25 oz/gold, 1346 oz/silver, 2540 lbs copper and 65,365 lbs/ lead (Miller, 1985). |
| MRZ-3a (h-4) (Shadow Mountain Area) | chr, m, c, a | Apparent stratabound copper deposit within arkosic quartzite (Wood Canyon Fm.) | | Low | None | Moderate potential for undiscovered resources | Mineralization appears to be stratabound within quartzite. If formation is continuously mineralized between prospects, USBM est. 6 million tons of 1.1% copper. |
| MRZ-3a (h-5) (Shaw Mine Area) | gl, sph, ce, s, Ha | Mineralized arcuate fault on the upper plate of a shallow thrust | | Low | Past production | Low potential for undiscovered mineral | Mine yielded 153 tons of ore between 1925-28 which averaged 18.4% lead, 12.6% zinc and 7.8 oz/ ton silver (Sabine, 1985). |
| MRZ-3a (h-6) (High Chicago Mine Area) | gl, sph, ce, s, hm, p, Hf, Ha | 9000' long mineralized zone along a NW trending bedding plane thrust | Hydrothermal alteration zone (hemitization) on Landsat imagery | Medium | Possible minor past production | Moderate potential for undiscovered resources | Five short adits and numerous pits. No production recorded; amount of stoping may indicate a minor amount of ore was produced. |
| MRZ-3a (h-7) (Red Wing Mine Area) | gl, sph, hm, g?, s, Hf, Ha | Vein striking S40NW in ferruginous Bonanza King Dolomite | | Low | Past production | Low potential for undiscovered resources | 90' deep inclined shaft with minor sublevel stoping. |
| MRZ-3a (h-8) (In Prospect Area) | m, a, chr, hm, s, g?, Ha | N-NE trending zone within fractured and sheared quartzite | | Low | | Low potential for undiscovered resources | Selected USBM samples contained 2.6-13.1% copper, minor cobalt and .001-.009 oz/ton gold. |

**ABBREVIATIONS**
**Mineral names:** a=azurite, ba=barite, bo=bornite, c=chlorite, ce=cerrusite, chr=chrysocolla, g=gold, ga=garnet, gl=galena, hm=hematite, m=malachite, p=pyrite, q=quartz, s=silver, sph=sphalerite
**Hydrothermal alteration:** Ha=argillic alteration, Hf=ferrunginous, Hsi=silicification

# PART II – SUPPORTING INFORMATION FOR MINERAL RESOURCE ASSESSMENT

## GEOGRAPHIC SETTING

The Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, Ryan, Pahrump, and Stewart Valley 15-minute quadrangles and the High Peak 7.5-minute quadrangle comprise the triangular-shaped area bounded by the eastern boundary of the Death Valley National Monument, the California-Nevada stateline, and the north 36°00' latitude line. Parts of the Ash Meadows, Big Dune, High Peak, Pahrump and Stewart Valley quadrangles lie within the state of Nevada; however, only those portions of these quadrangles occurring in California are included in this study .

The study area lies within the basin and range geomorphic province and encompasses five discrete mountain ranges separated by alluvial valleys and playas. The eastern part of the area includes the northern Nopah and Resting Spring Ranges which are composed of Late Precambrian and Paleozoic sedimentary rocks that form near vertical cliffs and ridges. The two ranges are separated by alluvial deposits of Chicago Valley. In turn, the rugged western escarpment of the Resting Spring Range yields to broad alluvial, playa, and dissected pediment deposits which characterize the Amargosa River drainage.

The Amargosa River drainage is bounded on the west by the Tertiary volcanic tablelands and moderate topography of the Greenwater Range. The Greenwater Range slopes westward into the alluviated deposits of Greenwater Valley which, in turn, is bounded by the moderate to steep topography of the Black Mountains that is comprised of Pliocene volcanics and older Precambrian gneiss and quartzites. The extreme northern portion of the study area includes the rugged peaks of the Funeral Mountains, composed principally of Paleozoic carbonate rocks which drop precipitously down to the broad alluvial fans and pediments of the Amargosa drainage. Elevations in the study area range from 6703 feet at Pyramid Peak in the Funeral Mountains to less than 1644 feet along the Amargosa River drainage at the southern boundary.

Primary access into the area is provided by California State Highways 127, 178, and 190 and by the secondary Greenwater Valley and Ash Meadows-Stewart Valley roads as shown on Figure 4. Additional access is provided by several mine roads and jeep trails, but overall, ground access is difficult due to the rugged terrain and scarcity of roads. The area is uninhabited with the exception of a small settlement at Death Valley Junction and the American Borate Company town located along State Highway 190 between Furnace Creek and Death Valley Junction .

The sparse vegetation in the study area consists mostly of sagebrush, cresote brush, cacti, grasses and small mesquite trees along the Amargosa River drainage. Summer temperatures exceed 100°F, while spring and fall are windy but mild, with winter temperatures below freezing. Annual precipitation is minimal for the region as typified by the vegetation.

## GEOLOGIC FRAMEWORK

### Previous Geologic Work

The general geology of the study area has been well described by several investigators (see Noble (1934), Hazzard (1937), Wright and Troxell (1966, 1967, 1971, 1976), Wilhelms (1963), Drewes (1963), Denny and Drewes (1965), McAllister (1970, 1971, 1973, 1976) and Burchfiel, Hamill and Wilhelms (1982, 1983)). The geologic map (Plate 1) which accompanies this report has been compiled and modified from geologic maps made by Wilhelms (1963), Drewes (1963), Denny and Drewes (1965), McAllister (1970, 1971, 1973, 1976), Troxel and Wright (1971), and Burchfiel, Hamill, and Wilhelms (1982).

Numerous reports have been published concerning mineral deposits in the study area. Waring and Huguenin (1917, p. 106) reported on the Red Wing silver-lead-zinc prospect and the Baxter Mine (gold, silver, lead, zinc, and copper). Noble (1926, p.63-73) and Tucker (1926, p.524-526) reported on the Gerstley Borate Mine. Descriptions of clay, volcanic ash, silica, and zeolite deposits near the Amargosa River were published by Tucker (1926, p.513-514), Hamilton (1921, p.297-298), Tucker and Sampson ( 1938, p.484-486), Droste (1961), Denny and Drewes (1965), and Sheppard and Gude (1968). Norman and Stewart (1951, p.76) and Goodwin (1957, p.495) reported on the Nopah (Nancy Ann) Mine. McAllister (1970, 1971, 1973) detailed the nature of the Furnace Creek borate area, Barker and Wilson (1975), Barker (1976), and Norman and Johnson (1980) described the general nature of borate deposits and specific deposits within the study area. Drewes (1963) described mineral deposits in the Funeral Peak quadrangle. Pantea (1980) described the lithology and lithium content of sediment samples from drilling at Alkali Flat. Cook (1980) discusses the uranium potential for the Death Valley 1° x 2° quadrangle. U.S. Bureau of Land Management unpublished mineral potential reports by Marcus (1980) and Schulte (1982, 1984, 1985) contain additional data. Detailed mineral resource reports have been prepared for the Nopah Range WSA (Sabine and Mayerle, 1985), Resting Spring Range WSA (Miller, 1985), Funeral Mountains WSA (Neumann, 1984) and Greenwater WSA (Rains, 1984).

A summary of the geology of the area is presented below. For more detailed discussions, the reader is referred to the bibliography at the end of this report.

### Regional Geology - Death Valley Area

The study area consists of typical basin and range topography where tilted fault blocks of the Nopah, Resting Spring Ranges, and Funeral Mountains are separated by valleys covered with alluvial sediments. Exposed bedrock consists of Late Precambrian and Paleozoic marine sedimentary rocks, Mesozoic mafic intrusives and Tertiary sedimentary, volcanic, and plutonic rocks.

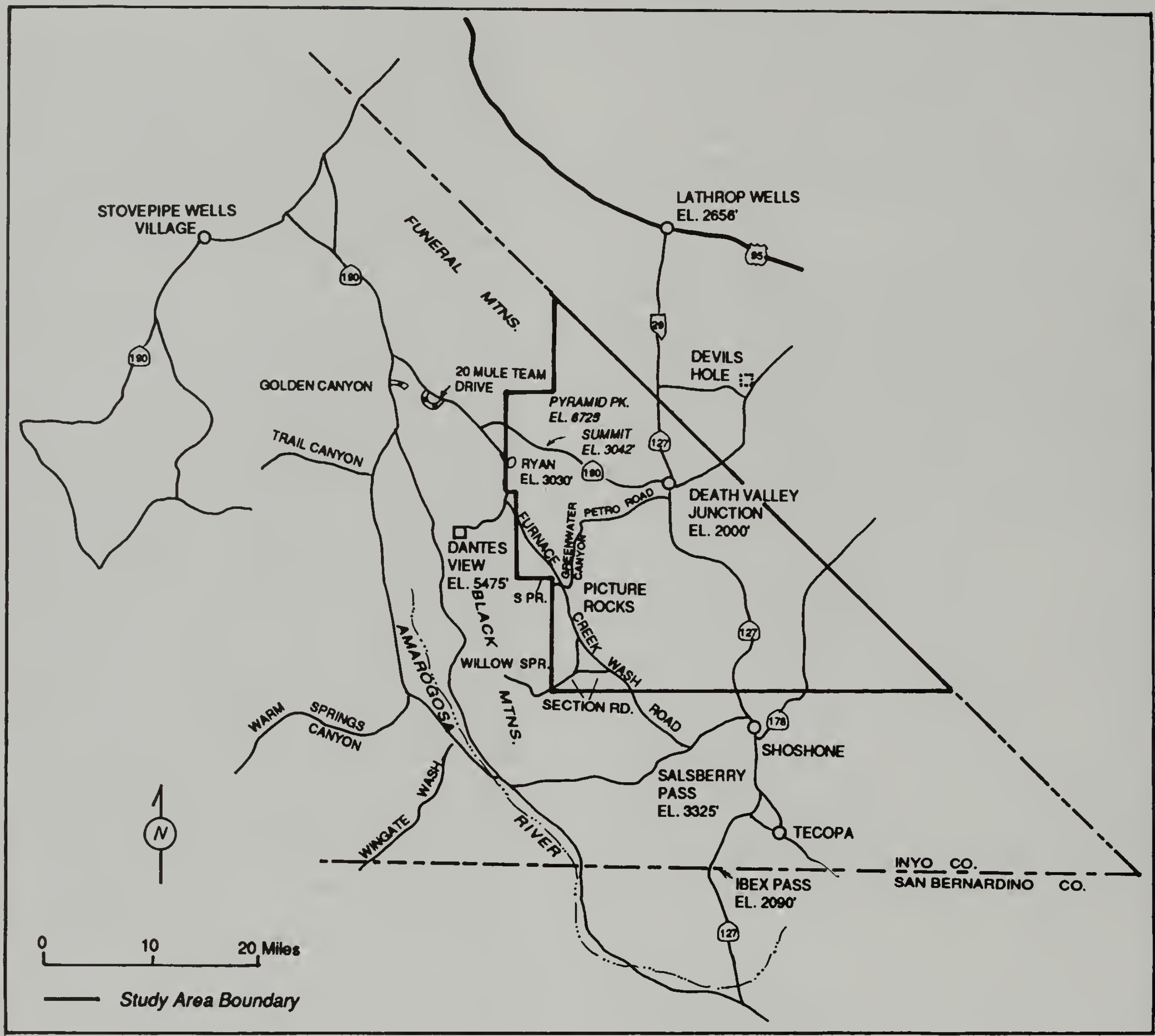


Figure 4. Location map of the southeast corner of the Death Valley 1° x 2° quadrangle.

### Precambrian and Paleozoic Rocks

The oldest rocks in the study area are an accumulation of sedimentary rocks and sill-forming diabase, Precambrian in age, as much as 5,500 meters thick, and essentially unmetamorphosed which are well-exposed in the Resting Spring Range, Nopah Range and, to a lesser extent, within the Funeral Mountains. Although these rocks have yet to yield a reliable radiometric date, the oldest probably were deposited about 1.4 billion years (b.y.) ago, as they rest with profound unconformity upon a crystalline complex from which 1.7 b.y. dates have been obtained elsewhere in the Death Valley region, and they have been intruded by diabase sills and dikes that seem best correlated with similarly disposed diabase bodies of central and southern Arizona, that are about 1.2 b.y. old (Wright and others, 1976). The youngest Precambrian strata of the Death Valley region conformably underlie beds that contain Early Cambrian fossils. The Precambrian sequence has long been recognized as composed of (1) a lower succession named the Pahrump Group, and (2) an upper succession comprised of the Noonday dolomite, Johnnie Formation, and Stirling quartzite. The two successions were originally defined as separated by an angular unconformity beneath the Noonday dolomite (Noble, 1934; Hazzard, 1937; Hewett, 1956; Wright and others, 1976) which constituted the provenance of the Cordilleran miogeosyncline. However, partly because carbonate rock rarely forms the initial deposit in a developing miogeosynclinal environment, later workers (Noble, 1941; Stewart, 1972) have suggested that the change in provenance is recorded in the pre-Noonday conglomeratic units, commonly diamictite, of the Kingstone Peak Formation (Wright and others, 1976). Data (Diehl, 1976, Wright and others, 1976) indicates that the occurrences of the Pahrump Group in the Death Valley region were deposited within a long-continuing west-northwest trending trough or basin with bordering platform areas that, at times, were inundated by shallow seas and, at other times, stood well above sea level to become source areas for basinal clastic sediments.

A nearly unbroken sequence of Precambrian crystalline basement rocks through Middle Pennsylvanian age rocks is present in the Nopah Range. The only major unconformity within the Nopah Range sedimentary sequence is at the base of the Devonian Nevada Formation, where it rests on Silurian Hidden Valley dolomite east of Chicago Pass and on upper Ordovician Ely Springs dolomite farther southeast. Only upper Precambrian through upper Cambrian rocks are present in the Resting Spring Range (Burchfiel and others, 1983).

### Mesozoic Rocks and Structures

Although a large area within the Black Mountains adjacent to the western study area boundary is underlain by a Mesozoic mafic intrusive complex, there are no Mesozoic stratigraphic sequences occurring in the study area. However, Pre-Mesozoic rocks were affected by two Mesozoic deformational events. After a long period of general subsidence from Late Precambrian to Pennsylvanian and probably to Middle Permian time, the first deformational events, folding and high-angle faulting, affected the area. Dating of these events is poor in the map area and can be bracketed only as occurring between the Middle Pennsylvanian and the Middle (?) Tertiary (Burchfiel and others, 1983). The second deformational event, low-angle thrusting, is evidenced by numerous thrusts in the Nopah and Resting Spring Ranges. Hydrothermal base metal mineralization within these ranges appears to have occurred during this orogenic period (Laramide?) of thrusting .

### Cenozoic Rocks and Structures

Post-thrusting structures include strike-slip faults, folds, high-angle faults, and tilting and warping of rocks within the ranges. Much of the present range and valley topography resulted from the formation of these structures. The age of the structures is not entirely clear, but some may be as old as Mesozoic, whereas most are probably Cenozoic (Burchfiel, 1983).

Evidence of Cenozoic deformation and sedimentation along the Furnace Creek strike-slip fault zone is found in two successions of sedimentary and volcanic rocks. The older, bracketed between 25 to 14 m.a., occurs in tilted fault blocks of the bordering Funeral Mountains, and preceded major crustal extension. The later succession, comprising the Artist Drive, Furnace Creek and Funeral Formations of the Furnace Creek basin ranges in age from about 14 m.a. to about 4 m.a. It records the subsidence and deformation of the trough, and was associated with right-lateral slip on northwest-striking faults. The sedimentation and faulting were accompanied by abundant plutonism and volcanism in the Greenwater Range and Black Mountains (Cemen and others, 1985).

Within the Black Mountains and Greenwater Range is a terrane composed primarily of Cenozoic intrusive and extrusive rocks. The volcanic rocks of the terrane are predominantly rhyolitic but also include dacitic, andesitic and basaltic units, and Cenozoic quartz monzonite plutons. These rocks appear to be genetically related to the Cenozoic deformational features of the block (Noble and Wright, 1954; Wright and Troxel, 1971). Cemen and others (1985) attribute the localization of the igneous activity southwest of the Furnace Creek fault zone to a greater degree of extension there than on the northeast side of the Furnace Creek fault.

A large percentage of the study area is underlain by unconsolidated or, at most, weakly indurated rocks of Quaternary age, principally alluvial-fan and playa deposits accumulated as sediments under present stream channels and on pediments that were left as alluvium-covered terraces by faults along basin margins and by entrenchment. Over broad areas, these rocks are not exposed in section; only in a few places have they been dissected to depths of 30 to 50 feet.

## MINERAL RESOURCE ASSESSMENT

### Mining History

In all likelihood, prospecting in the study area began with the first parties of emigrants to travel through the area, probably in the late 1840's to early 1850's. Hausmann, 1908, pg. 339, refers to the claim that the Greenwater Copper district was probably discovered by emigrants in the early 1850's, although the property was not developed until 1905. According to Latschar (1981) by 1907, 2,000 inhabitants in four towns, 73 incorporated mining companies, and 140 million in mining capital were in the Greenwater Mining district. The copper boom collapsed when shafts more than 1,400 feet deep failed to reveal sufficient ore. By 1908, the district was virtually abandoned with only small amounts of ore (Aubury, 1908, credits only one shipment of ore made in 1907) having been produced.

The copper boom at Greenwater between 1905-1907 undoubtably brought many prospectors into the region. Thus, by 1910 the High Chicago group of claims were being worked; the Red Wing Mine was in production, and by the early 1920's shipments of lead-zinc-silver ore were recorded for both the Baxter Mine and Nancy-Ann Mine. Overall, production from metallic mines in the study area has been extremely small; and with the exception of the Greenwater District, probably none of the other mines ever employed more than a dozen miners at any one time.

The existence of borates at the mouth of Furnace Creek Wash was discovered in 1881 and production began in 1882 at the Harmony Borax Works. Also in 1882, the new borate mineral, colemanite was discovered in the hills adjacent to Furnace Creek Wash. In 1884, the colemanite ore body at the Lila C. Mine was discovered although development work did not begin until 1903. However, it was not until 1907, when the Tonopah and Tidewater Railroad was completed to Death Valley Junction, that production began from the Lila C. Mine. The Lila C. operated continuously from 1907 to 1914, at which time the high grade ore bodies became depleted and the Pacific Coast Borax Company moved its operation to the new mine camp at Ryan. By 1915 about 150 men, working the Upper and Lower Biddy McCarty, the Played Out, the Grand View, the Oakley, the Lizzy V., and the Widow Mines were producing about 250 tons of colemanite a day. These mines operated continuously until 1928, when the sodium borate (kernite and borax) mine near Boron was brought into production by Pacific Coast Borax Company and the mining operations at Ryan were shut down.

In recent years, exploration surveys have been conducted by mining companies in several areas within the study report. In the mid-to-late 1970's Tenneco Mining Company conducted an extensive seismic survey along the eastern side of the Greenwater Range from Deadman Pass Road northwest almost to Ryan. This seismic survey was later followed by an extensive drilling program on sub-surface structures deemed favorable for borate mineralization.

Rosario Exploration Company located a block of lode claims on the projected extension of the Gerstley Lake Beds in Chicago Valley and had planned exploratory drilling for borates in 1982. The company has since abandoned the claims without drilling.

The Greenwater Valley Area immediately southeast of Greenwater Canyon, as evidenced by the presence of old claim posts, shallow dozer cuts, and numerous pits was the site of an extensive exploration program, probably during the 1950's or 1960's that was probably conducted for precious metal mineralization associated with the disseminated barite veins present in the area. Part of this area is currently claimed by the Johnson Exploration Company, which has done some drilling on its block of claims.

Currently, the study area has five industrial mineral producers: American Borate Company and U.S. Borax produce calcium borates from the Billie Mine and Gerstley Mine respectively; Anaconda Minerals produce the zeolite clinoptilite from its Ash Meadows Mine (now under lease to and operated by Zeolites International); Industrial Mineral Ventures produces hectorite from its mine near Franklin Well, and the R.T. Vanderbilt Company produces bentonite from its Sidehill Mine.

### Mineral Land Classification

As indicated in the Geology section, the occurrence and distribution of mineral deposits closely relates to the geologic framework of the eastern Death Valley Region, whereby certain terranes are favorable geologic environments for specific types of mineral deposits. Mineral land classification reflects these relationships.

The Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, High Peak, Ryan, Pahrump, and Stewart Valley quadrangles were evaluated for the presence or likely occurrence of specific metallic and industrial mineral deposits based on past mineral production and modern geologic concepts relating to formation of mineral deposits. The following types of deposits were identified in this study:

1. Deposits containing gold, silver, copper, lead, and zinc bearing minerals formed by hydrothermal cavity-filling and replacement processes.
2. Industrial minerals–deposits containing borates, barite, bentonite, carbonate rock, clay, lithium, perlite, pumice, quartzite, saline, and zeolite minerals formed by various processes which include: evaporation, devitrification, chemical alteration, precipitation, sediment transport and volcanism.

Mineral resource zones relative to each type of deposit are presented in a series of maps (Plates 2 and 3) that accompany this report. Descriptions of the nature and occurrence of the deposits and the mineral resource zones follow.

## MINERAL RESOURCE ZONES

### AREAS CLASSIFIED FOR INDUSTRIAL MINERALS

Industrial minerals known to be present in the area include borates, barite, carbonate rock, clay, lithium, perlite, pumice, quartzite, salines and zeolites. Superscripts (e.g., MRZ-2a$^{(bo-1)}$) are used to define the industrial mineral commodity.

Mineral land classification of the Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, Ryan, Pahrump, Stewart Valley 15-minute quadrangles and High Peak 7.5-minute quadrangle, with respect to industrial mineral deposits, is presented on Plate 2. These specific areas are discussed below in general order of their importance.

## Areas Classified as MRZ-2a

Areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present. As shown on Figure 3, MRZ-2 is divided on the basis of both degree of knowledge and economic factors and MRZ-3 with respect to knowledge of economic characteristics of resources. Areas classified MRZ-2a include discovered mineral deposits that are measured or indicated reserves as determined by such evidence as drilling records, sample analysis, surface exposure, and mine information. Land included in the MRZ-2a category is of prime importance because it contains known economic mineral deposits of significance.

*Ryan Borate Mines, MRZ-2a^(bo-1)*: The Ryan area has been the site of borate production since 1914 when Pacific Coast Borax Company bought the Upper and Lower Biddy McCarty, the Played Out, the Grand View, the Lizzy V, the Oakley, and the Widow Mines into production. Currently, American Borate Company operates the Billie Mine about 1.5 miles north-northwest of Ryan and U.S. Borax has initiated a step out drilling program southeastward from their patented property holdings in the Ryan area.

Evans (1975) listed 3,913,400 tons of indicated and inferred reserves of colemanite, and 2,060,000 tons of indicated and inferred reserves of ulexite-probertite as being contained in the U.S. Borax properties in the Ryan area. These reserves occur in the Widow #3, Widow #7, Lizzie V. Oakley, Grand View, upper and lower Biddy McCarthy, and Played Out Mine properties. At present, U.S. Borax is actively exploring the areas to the south and east of these patented holdings. The MRZ-2a line encircling the Ryan area has been delineated on the basis of proprietary drilling information furnished by U.S. Borax to the Division of Mines and Geology.

*Gerstley Mine Area, MRZ-2a^(bo-2)*: This area, adjacent to the southern boundary of the study area, contains the U.S. Borax Gerstley Mine property and the undeveloped Gerstley II deposit which is claimed jointly by American Borax Company and U.S. Borax.

The Gerstley Mine has been an intermittent operation since 1945, with yearly production typically ranging from 500 to 2,000 tons of borates. Evans (1975) shows a measured reserve of 82,700 tons of ulexite and an indicated reserve of 141,300 tons of colemanite for the Gerstley Mine. U.S. Borax has completed additional drilling on the deposit since 1975 and delineated additional reserves.

The Gerstley II deposit was outlined by exploration drilling performed by Tenneco Mining Company during the mid-1970's . The deposit is blind, occurring between 120 to 700 feet below ground surface. Evans (1975) credits the deposit with an indicated resource of 1,000,000 tons of combined colemanite and ulexite.

*Maria Deposit Are, MRZ-2a ^(bo-3)*: The Maria deposit is blind, occurring at a depth of between 600 to 700 feet below the surface. The deposit was delineated by exploration drilling, initiated by Tenneco Mining Company in the mid-1970's; a nine-claim block has been patented but the deposit is undeveloped. Evans (1975) listed an indicated resource for the area of 700,000 tons of colemanite .

*Anaconda Zeolite Mine Area, MRZ-2a ^(z-4)*: A large deposit of zeolite-bearing tuff occurs about 5 miles east of Death Valley Junction and one mile west of the California-Nevada border. The deposit lies within a sequence of Tertiary age rocks underlying the lowlands north and northwest of the Resting Spring Range and is largely concealed beneath younger formations. These rocks were mapped by Denny and Drewes (1965) and placed in a "sandstone and claystone" unit of possible Oligocene-to-Pliocene age. The rocks consist of moderate-brown to very light gray, locally yellow or green, sandstone and claystone, with subordinate amounts of conglomerate, siltstone, tuff, and limestone and were deposited both as alluvial fans and as lake sediments (Denny and Drewes, 1965). Clinoptilolite is the only zeolite mineral identified in samples collected from the Anaconda pit (Stinson, 1984).

This pit, when visited in April 1985, was about 500 feet in length (east-west), over 250 feet wide (north-south) and 35 to 45 feet deep. The yellowish-white zeolite-bearing tuff bed strikes north-south and dips at about 25° to the east. Several near-vertical faults are exposed in the pit walls which appear to have provided conduits for the circulation of groundwater necessary to initiate zeolitization. The deposit has been extensively drilled on a grid basis by Anaconda, and measured reserves of clinoptilolite in excess of 50 million tons have been delineated. The deposit is currently being leased and operated by Zeolites International, with an annual production of 5,000-10,000 tons of sized material being produced by their crushing plant located at Ash Meadows.

*Sidehill Bentonite Mine Area, MRZ-2a ^(b-5)*: This area is located on the extreme southeastern tip of the Funeral Mountains and encompasses the four patented claim holdings of the R.T. Vanderbilt Company. The Sidehill Mine is an active producer of bentonitic clay utilized for cosmetic and pharmaceutical purposes. The clay is intermittently mined from two beds, as much as twenty feet thick, that strike N10°-30°E and dip 40°SE. Workings include an adit, two shafts and several surface cuts from which material is produced and stockpiled.

*Industrial Mineral Ventures Hectorite Mine Area, MRZ-2a ^(b-6)*: This area is located immediately west of Franklin Well, and contains the active Industrial Mineral Ventures (IMV) Hectorite Mine. Hectorite, a lithium-bearing clay sold as a drilling mud and as a component in construction materials, is mined from Quaternary lake sediments adjacent to the Amargosa River. The deposit, which was formed from the alteration of water-lain volcanic sediments, trends in a northwest direction across Sections 5, 6, 31, and 36 T.18 N., R.4 E. The deposit, covered by a thin veneer of colluvial and alluvial sediments, has been grid drilled by IWV and, in cross-section, resembles a flattened cigar-shape with a northwest axial trend and shows abrupt lateral termination. Hectorite is cemented with calcium carbonate and the deposit was probably formed by a line of calcium-rich hot springs along the margin of a Quaternary lake in which volcanic sediments were being deposited.

## Areas Classified as MRZ-2b

Areas underlain by mineral deposits where geologic information indicates that significant inferred resources are present. Areas classified MRZ-2b contain discovered deposits that represent either inferred reserves or deposits that are presently subeconomic as determined by limited sample analysis, exposure, and past mining history. Further exploration work and/or changes in technology or economics could result in upgrading areas classified MRZ-2b to MRZ-2a. The MRZ-2b designation is applied to areas where geologic evidence indicates there is a high likelihood that economic concentration of minerals are present.

*Lila C. Borate Mine Area, MRZ-2b$^{(bo-7)}$*: This area encompasses the Maria deposit, MRZ-2a$^{(bo-3)}$, and includes two U.S. Borax properties (Lila C. Mine and Cone Hill claim group) and the American Borate Company Terry Mine.

The Lila C. Mine was brought into production in 1907 and operated until high-grade ore was exhausted in 1914 and Pacific Coast Borax Company moved its operation to the Ryan properties. Evans (1975) lists the property as being mined out; however, U.S. Borax has indicated that marginal, subeconomic borate reserves exist at the property.

U.S. Borax holds six claims (Cone Hill Group) which were patented in the early 1900's on the basis of surficial exposures of colemanite. Deposits have been developed by several short adits but no production has been recorded for the property. To date the company has not drilled the Cone Hill Group and as a consequence measured reserve figures are not available.

The Terry Deposit, occurring at a shallow depth of 15 to 25 feet, was open-pit mined in 1974-1975 by Tenneco Mining Company. Evans (1975) lists an indicated reserve of 2,000 tons of colemanite for the deposit.

The Lila C. Mine, Terry Mine and Cone Hill Claim Group have been consolidated into a MRZ-2b$^{(bo-7)}$ zone surrounding the Maria deposit because demonstrated economic reserve figures are not available for these properties. However, it should be pointed out that additional drilling at any of these properties would, in all probability, upgrade the classification to MRZ-2a.

## Areas Classified as MRZ-3a

Areas underlain by geologic settings within which undiscovered mineral resources similar to known deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Lands classified MRZ-3a represent areas in geologic settings which are favorable environments for the occurrence of specific mineral deposits. In the classification diagram, these lands are referred to as hypothetical resources. Further exploration work within these areas could result in reclassification of specific locations into the MRZ-2a or MRZ-2b categories. Areas in which there is direct evidence for mineralization of undetermined significance are placed into the MRZ-3a category.

*Ash Meadows Area, MRZ-3a $^{(z,b-8)}$*: This area encircles the Zeolites International Pit MRZ-2a$^{(z-4)}$ and includes an area underlain by extensive deposits of alluvial and lacustrine sediments of Tertiary age. The MRZ-2a$^{(z-4)}$ zone was delineated on the basis of Anaconda's active claim block which contains in excess of 50 million tons of measured reserves of clinoptilolite. Step-out drilling from this measured reserve has revealed the presence of zeolite and bentonitic clay resources at depth. The existence of hot spring deposits containing minor borate mineralization (anomalously-high lithium and strontium values) coupled with possible structural basins existing during Tertiary time also make the area potentially favorable for borate deposits.

*Eastern Funeral Mountains Area, MRZ-3a $^{(b-9)}$*: This area lies along the Eastern flank of the Funeral Mountains and encompasses a broad area underlain by Tertiary tuffaceous sedimentary rocks which contain concentrations of bentonitic clay and minor zeolites. Currently, bentonite is being produced at the Sidehill Mine, MRZ-2a$^{(b-5)}$, and numerous pits, cuts, shafts, and short adits exist on the Yellow Heart, Deborah, Kaolin, and King Fish 1 and 2 prospects which reveal bentonitic clay resources, although the commercial applicability of the resources is not known.

*Alkali Flat Area, MRZ-3a $^{(na, li, U-10)}$*: This area, located immediately north of Eagle Mountain, encompasses an area of Quaternary lake sediments. Remnants of some very limited operations for the recovery of saline minerals are found in the NW $^1/_4$ Section 7, T. 24 N., R. 6 E., where several old evaporation ponds have been constructed by earth berms on the alluvial floor. These operations probably occurred in the period 1948 to 1960, when a number of sodium prospecting permits were issued on Alkali Flat (Schulte, 1982). In 1973, Chemstone Corporation and, in 1976, Industrial Mineral Ventures, applied for sodium prospecting permits in this area. A drill hole by the U.S. Geological Survey detected up to 810 ppm lithium and 46 ppb uranium in calcareous muds at a depth of 135 feet (Pantea, 1980). This general area has also been shown to be anomalous in uranium by NURE Airborne Radiometric Surveys (Cook, 1980).

*Nopah Range-Resting Spring Range-Southern Funeral Mountains, MRZ-3a $^{(ls, si-11)}$*: As shown on Plate 2, portions of the Nopah Range, Resting Spring Range and the southern part of the Funeral Mountains within the study area have been classified MRZ-3a$^{(ls\ 1,\ si-11)}$ and MRZ-3a$^{(ls\ 2, si-11)}$ for carbonate and siliceous rock.

The areas shown as MRZ-3a$^{(ls2,\ si-11)}$ contain carbonate rock that is predominantly limestone of Devonian to Mesozoic age, which includes the Stewart Valley, Monte Cristo, and Bird Springs formations. Although there has been no production from these areas, these formations or similar-age formations, have recorded production elsewhere in the Mojave Desert province and, as a consequence could contain important resources of carbonate rock as shown in California Division of Mines & Geology Bulletin 194.

The areas shown as MRZ-3a$^{(ls2,\ si-11)}$ contain carbonate rock that is predominantly dolomite of Precambrian to Silurian age and includes the Bonanza King, Nopah, Pogonip, Ely Springs, and Hidden Valley formations. Carbonate rocks of equivalent ages have produced dolomite in other areas of California and the Western

United States and, as a consequence, these areas could contain resources as shown in CDMG Bulletin 194. Also included in this classification are several formations, principally the Stirling, Zabriskie, and Eureka, which contain bedded quartzites that may be of sufficient quality to be of commercial value for silica brick manufacture and/or portland cement additive.

*Eastern Greenwater Range, MRZ-3a* (z-12): This area, located about halfway between the mouth of Greenwater Canyon and Ryan on the eastern slope of the Greenwater Range, is underlain by discontinuous outcrops of variegated tuff-breccia of the upper pyroclastic member of the Oligocene (?) Artist Drive Formation (McAllister, 1966). Some units appear to be well lithified and partly zeolitized (test samples revealed the presence of clinoptilolite, F. Johnson, personal communication). No production has been recorded from this area, although parts of the upper member of the Artist Drive formation may contain sufficient quantities of zeolites to be of commercial value.

*Greenwater Mining District Area, MRZ-3a* (ba-13): An area extending southeastward from the site of Greenwater for almost 15 miles along the margins of Greenwater Valley contains numerous prospects that explored copper-bearing barite veins. The most prominent barite veins occur in the Greenwater Mining District, which was the site of intense copper mining activity during the period 1905 to 1908. Minor secondary copper minerals with some silver mineralization occur with barite and quartz, which fill small open veins and tight fractures and, in places, are part of the matrix of fault breccia. The longest vein or system of veins is about half a mile long, commonly trend N30°-65°E or N30°-70°W and dip steeply, pinch and swell along strike and may attain localized widths up to 2.5-3 feet. Although widely distributed, no barite production has been recorded from this area, and it is not known if these veins are of sufficient quality and quantity to be of economic importance.

*Eagle Mountain Area, MRZ-3a* (s-14): The southeastern terminus of Eagle Mountain is the site of two historic building stone quarries. The southernmost, consisting of small pits and trenches, apparently produced a red-colored shale from Tertiary sedimentary rocks with less than 10,000 yards of stone being mined (Miller, 1985).

The second quarry, located on the western side of Eagle Mountain, produced a grey- to brown-colored quartzite from small pits and trenches. Miller (1985) estimated less than 10,000 yards had been mined at this property.

A third quarry, the Gold Junction Quarry, is located immediately west of Highway 127 due west of Eagle Mountain, and apparently produced volcanic construction materials. Miller (1985) estimated that less than 100,000 yards of volcanic rocks may have been mined from the site.

*Greenwater Canyon Area, MRZ-3a* (pu-15): Tuffaceous pumicite and pumiceous tuffs are abundant in parts of the Greenwater Volcanics and the Funeral Formation. The purest pumicite is pact of the tuff-breccia member of the Greenwater Volcanics and lies on both sides of Greenwater Canyon east of Peak 5107. This bed of pumicite is about 40 feet thick and contains pumice fragments from sand-size to 18-inch cobbles. Another group of pumicite beds lies about 1500 west of Greenwater Canyon where an exposure of massive to coarsely cross-bedded, well-sorted pumicite about 50 feet thick is exposed. The lateral extent of these deposits is unknown; however, rapid changes in the lithology of beds can be expected (Drewes, 1966).

## Areas Classified as MRZ-3b

Areas that may contain undiscovered mineral resources that occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential (speculative resources). Lands classified MRZ-3b represent areas in geologic settings which appear to be favorable environments for the occurrence of specific mineral deposits. In the California Mineral Land Classification Diagram, these are referred to as speculative resources. Further exploration work could result in the reclassification of all or part of these areas into the MRZ-3a category or specific localities into the MRZ-2a or MRZ-2b. Areas for which there is only indirect evidence of mineralization are placed in the MRZ-3b category.

*Eastern Greenwater Range - Amargosa Valley Area, MRZ-3b* (bo-16): This broad zone, which encompasses several areas known to contain proven borate resources, represents a synthesis of both published and proprietary company data regarding the delineation of a zone deemed to be favorable for borate mineralization.

Borate deposits in the Death Valley area are of two distinct types:(1)accumulations of ulexite and associated borate minerals in Holocene playa lake beds that occupy the floor of Death Valley and which have not been commercially exploited since about 1883; and (2)colemanite, ulexite, probertite, and associated minor borate minerals in bedded lake accumulations that occur interstratified in the Pliocene Furnace Creek Formation.

The Furnace Creek Formation lies between the Oligocene (?) to Pliocene Artist Drive Formation and the Pliocene to Pleistocene Funeral Formation. These formations have been folded into a broad syncline cut by steeply-dipping faults with minor displacements. On the east, the formations are separated from the Paleozoic rocks by the northwest-trending Furnace Creek fault zone and on the west by the Frontal Fault System that borders the east side of Death Valley.

The Furnace Creek Formation is composed of a maximum of about 7,000 feet of inter-layered and interfingered ancient lake beds, clastic sedimentary rocks, pyroclastic rocks, and flows of vitrophyric and basaltic rocks. Major known deposits of colemanite and ulexite-probertite are found within several tens of feet to about 500 feet above the base of the formation. The main borate deposits are interlayered with mudstone, shale, limestone, conglomerate, and gradational variations of various rocks (McAllister, 1970).

The western boundary of the MRZ-3b zone has been drawn on the basis of where the eastern dipping Furnace Creek Formation may stratigraphically pinch out under the overlying Funeral Formation and/or alluvial cover.

On the northeast border, the Furnace Creek fault zone is generally accepted as truncating the Furnace Creek Formation (McAllister, 1973); thus, the MRZ-3b zone parallels the Furnace Creek fault zone into the area of Eagle Mountain where additional structural complexities may occur from bifurcation of the Furnace Creek fault zone (Cemen and others, 1985). Here the MRZ-3b zone has been bent to the northeast to encompass an area that possesses several characteristics, specifically, the apparent outcrops of Artist Drive Formation on the southeast side of Eagle Mountain and gypsiferous Tertiary sediments along the base of Resting Spring Range, deemed potentially favorable by industry (i.e., the outcrops of gypsiferous Artist Drive Formation could indicate the existence of an underlying structural basin containing Furnace Creek Formation lying between Eagle Mountain and the Resting Spring Range) for borates. Continuing southward, the MRZ-3b zone is drawn west of isolated areas of Paleozoic bedrock exposures, until modified in the Gerstley Mine area by outcrops of the Gerstley Lake Beds and faulting.

*Chicago Valley Area, MRZ-3b (bo-17)*: The Chicago Valley area has been classified MRZ-3a for borates. The Gerstley Lake Beds consist of more than 1,000 feet of lacustrine sedimentary rocks that include three zones of colemanite, ulexite, and probertite, totaling 150 feet in thickness (Wilhelm, 1963; Barker and Wilson, 1975). The lake beds have been traced south-eastward from the Gerstley Mine into Chicago Valley (Barker and Wilson, 1975). Tertiary-age playa sediments outcrop along the faulted valley margins which have revealed minor amounts of borate mineralization, which also has been found in drill holes sited within the valley floor.

*Franklin Well Area, MRZ-3b (b-18)*: This area borders both sides of the Amargosa River near Franklin Well and encompasses a broad area underlain by Quaternary lake sediments. It encompasses Industrial Mineral Ventures hectorite (a lithium-bearing clay) deposit (MRZ-2a(b-6)) which formed from hydrothermal alteration of Quaternary lake volcanic sediments adjacent to a hot spring center.

*Stewart-Pahrump Valley Area, MRZ-3b (na, bo-19)*: Stewart and Pahrump Valleys, underlain by Quaternary lake sediments, has been classified MRZ-3b(na, bo-19). Although basins such as Stewart and Pahrump Valley are generally favorable for borates, these particular areas are lacking in known deposits of Tertiary-age lakebeds or volcanic rocks which are normally associated with borates. However, due to its proximity to known borate resources, a MRZ-3b classification is given.

*Greenwater Range Area, MRZ-3b(p-20)*: Vitrophyric rocks of the Greenwater Volcanics along the lower margins of Greenwater Canyon contain perlitic structures (Drewes, 1966). Exposures of Greenwater Volcanics and Shoshone Volcanics southeast of Deadman Pass and along the western margin of Greenwater Valley, adjacent to the Monument boundary, show development of perlitic structures in contained vitrophyric rocks. Because of these widespread exposures of perlitic horizons, although of probable substandard grade, all rhyolitic volcanics, Tvr and Pvr have been assigned into the MRZ-3b(p-20) category for perlite.

*Shoshone Area, MRZ-3b(z, pu-21)*: Tuff deposits of Pleistocene Lake Tecopa consist chiefly of mudstone and interbedded rhyolitic vitric tuffs that interfinger marginward with coarser clastic sediments (Sheppard and Gude, 1968). The deposits of Lake Tecopa extend about 14 miles in a north-south direction and about 11 miles in an east-west direction. The towns of Shoshone and Tecopa lie near the north and south ends respectively of the lake deposits. The ash beds (tuff) within the lake deposits of Lake Tecopa on the western half of the area are delineated by mapping by Chesterman (1973). During diagenesis, zeolites, potassium feldspar, and other authigenic silicate minerals formed in the tuffs. The zeolites are mainly phillipsite, clinoptilolite, erionite, and minor amounts of analcime and chabazite (Stinson, 1984).

A few hundred yards southeast of the town of Shoshone are some low-terraced hills underlain mostly by nearly-horizontal lacustrine sedimentary rocks of Quaternary age. A layer of grayish-white pumicite (volcanic ash) that averages about 12 feet in thickness forms a prominent unit in these beds. This pumicite layer is flat-lying, and is overlain and underlain by sands and gravels which, locally, are cemented with siliceous material (Chesterman, 1956). The northward extent of this deposit is unknown; however, Quaternary lake beds present along the Amargosa River drainage and older alluvium along the southernmost boundary of the study area conceivably could contain zeolitic and pumiceous material of commercial value.

*Greenwater Valley Area, MRZ-3b (ba-22)*: As mentioned previously and classified MRZ-3a(ba-13), the Greenwater Mining District was the site of intense exploration along a system of copper-bearing barite veins. The margins of Greenwater Valley, southeastward from the site of Greenwater contains numerous prospects that explored copper-bearing barite veins. Barite occurs commonly as small veinlets, and as discrete crystalline masses, however, total vein thickness is usually measurable in inches; thus commercial development is highly unlikely for any of these occurrences.

### Areas Classified as MRZ-4(i)

These are areas where available geologic information does not rule out either the presence or absence of industrial mineral resources. These areas represent geologic environments in which industrial minerals of any type could occur.

Two areas of the study area have been classified MRZ-4. These are: the western side of the Greenwater Range, which is overlain by Tertiary-age volcanics and the area immediately north of Death Valley Junction, an area encompassing a deep alluvial basin for which limited geologic data is available.

## AREAS CLASSIFIED FOR HYDROTHERMAL MINERALIZATION

Within the study area, gold, silver, copper, lead, and zinc-bearing hydrothermal mineral deposits are present within the northern Nopah Range, Resting Spring Range, Greenwater Range and Valley and the eastern flank of the Black Mountains. Non-metallic deposits of clays, barite, borates, and zeolites are present in the Funeral Mountains, Greenwater Range, Black Mountains, and northern Resting Spring Mountains-Ash Meadows areas.

Mineral land classification of the Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, High Peak, Ryan, Pahrump, and Stewart Valley quadrangles with respect to hydrothermal ore deposits is presented on Plate 3. In all cases, it is assumed that the deposits are controlled by local structures along which mineralization occurs. These areas may include prospects and inactive mines of undetermined significance. Mineral Resource Zones for this class of deposits are denoted by the superscript "h" (e.g., MRZ-3$^{(h)}$. There were no areas which met the qualifications for classification into the categories of MRZ-1$^{(h)}$, MRZ-2a$^{(h)}$, and MRZ-2b$^{(h)}$.

### Areas Classified as MRZ-3a$^{(h)}$

Land classified MRZ-3a$^{(h)}$ has been grouped into six areas which are labeled on Plate 3 as MRZ-3a$^{(h-1)}$ through MRZ-3a$^{(h-6)}$. These specific areas are discussed below in general order of their importance.

A broad zone, principally containing copper and barite mineralization with minor amounts of gold, silver, and lead, occurs along the margins of Greenwater Valley from near Miller Spring northwestward about 15 miles to the vicinity of Dantes View. Several areas within this broad zone contain centers of mineralization which are discussed separately below.

*Greenwater Mining District, MRZ-3a$^{(h\text{-}1)}$*: The majority of the Greenwater Mining District lies within the Death Valley National Monument, although the area lying just outside the Monument, about 1.5 to 2 miles westward from the old site of Greenwater, probably supported the most intensive mining activity during the period 1905 to 1908. According to Latschar (1981), surface evidence of copper mineralization was found in the Greenwater district in 1905. By 1907, 2,000 inhabitants in four towns, 73 incorporated mining companies, and $140 million in mining capital existed in the district. The boom collapsed when shafts more than 1,400 feet deep failed to reveal sufficient ore to sustain mining. By 1908, the district was virtually abandoned, with only small amounts of copper having been produced (Aubury, 1908, credits only one shipment of ore made in 1907).

Numerous shafts exist in the area, all being inaccessible, although the prominent vein systems that the shafts were sunk upon are visible at the shaft collars. Drewes (1963) describes the copper mineralization as being chiefly an unidentified group of blue-green copper silicates and carbonates within rhyolitic intrusive rocks near their contact with Tertiary monzonitic rocks. Secondary copper minerals commonly occur with barite and quartz and, in some places, also with hematite, other iron oxides, and calcite. Copper sulfides are rare, consisting of small, isolated blebs of chalcopyrite. The minerals fill small open veins and tight fractures and, in places, are part of the matrix of fault breccia. The longest vein or system of veins is about half a mile in length. Two-thirds of the richer veins trend N°30-65°E and dip steeply; the other veins trend N30°-70°W and also dip steeply.

*Eastern Greenwater Valley Area, MRZ-3a$^{(h\text{-}2)}$*: Scattered occurrences of copper and barite mineralization are revealed along the eastern margin of Greenwater Valley from near Greenwater Canyon southeastward to Miller Spring. Typically, prospects exhibit minor secondary copper mineralization associated with hematite-barite-bearing veins carrying gold and silver values contained within an older sequence of scoriaceous volcanic extrusive rocks (andesites?) that are closely associated with Tertiary intrusive rocks.

Numerous shallow shafts (maximum recorded depth of 90 feet), pits, and open cuts exist in this area which represent mining activity that was probably contemporaneous with the high interest shown in the Greenwater district in the early 1900's. An area just south of Greenwater Canyon appears to have been extensively prospected and sampled probably in the 1950's or 1960's as a large number of sample pits and bulldozer cuts exist. Currently (April 1985), this area is held by Johnson Exploration Company with a large block of contiguous claims that straddle Greenwater Valley to the boundary of patented holdings at Greenwater.

*Baxter Mine Area, MRZ-3a$^{(h\text{-}3)}$*: The central Resting Spring Mountains contain three mines which have recorded limited mineral production. The most northerly is the Baxter Mine area which, according to U.S. Bureau of Mines records, from 1920 to 1927 produced 43 tons of ore containing 25.04 oz gold, 1,346 oz silver, 2,540 lb copper and 15,365 lb lead .

Workings encompass 47 small pits, 8 shallow shafts, and 23 short adits; underground workings total 1,250 feet (Miller, 1985). Mineralization occurs within a northwesterly- trending zone approximately 500 feet wide and over a strike length of 9,000 feet. Irregular pod-like, mineralized masses and vein fillings occur along shears, breccia zones, and fractures near or between thrust faults developed in dolomite and quartzite of the Bonanza King and Stirling Quartzite Formations. Sulfide minerals include galena, chalcopyrite, pyrite, and sphalerite; with complex secondary oxides, carbonates, and silicates of lead, copper, zinc and iron developed in the oxidized zone.

*Northern Nopah Range Area, MRZ-3a$^{(h\text{-}4)}$*: The northern Nopah Range contains the sites of two small hydrothermal mineral occurrences. The most northerly occurrence is the Nancy Ann Mine (formerly the Shaw Mine), an inactive lode mine that had a small production of silver, lead, and zinc. According to Sabine and Mayerly (1985), USBM and CDMG production records indicate that from 1925 to 1928, 153 tons of ore which averaged 18.4 percent lead, 12.6 percent zinc, and 7.8 oz/ton silver were produced. In 1943, five cars were shipped to the defense stockpile at Jean, Nevada. Three cars averaged 30 percent lead and 17 oz/ton silver and two cars contained 30 percent zinc.

Workings consist of two shallow shafts, five short adits and numerous pits and trenches. The main workings developed a 2 to 3 inch thick vein of oxidized lead, silver, and zinc minerals which follow an arcuate, steeply-dipping fault. Additionally, a northwest-trending fault, which averages less than 0.5 foot in thickness and extends 280 feet through the main workings, and some minor northeast-trending features, are also mineralized (Sabine, 1985). However, all mineralization is limited to the upper plate of a shallow thrust (less than 50 feet thick) separating Mississippian-age Monte Cristo Formation from Cambrian Bonanza King Limestone (Wilhelms, 1962).

The second occurrence, Barnett Prospect, consisting of two shallow pits and a 30 foot crosscut, explores a 2 feet thick gossan zone of limonite, goethite and argentiferous galena in massive Ely Springs Dolomite of Ordovician age. The gossan zone is less than 100 feet along strike and field observations of the worked area and surrounding vicinity revealed little signs of any significant sulfide mineralization.

*Red Wing Mine Area, MRZ-3a (h-5)*: The Red Wing Mine workings include an inclined shaft, 90 feet deep, with minor sublevel stoping. A podiform ore body is developed along a vein striking S40°W and dipping 50°SE, in a massive ferruginous dolomite of the upper Bonanza King Formation. Bright red iron oxide gossan has developed on massive hematite and goethtite, with minor oxides of lead and zinc present. It was mined for zinc and lead, prior to 1917 (Waring, 1917). No production records are available, but the size of workings indicate only minor production.

*High Chicago Mine Area, MRZ-3a (h-6)*: The High Chicago Mine workings consist of 19 small pits and trenches and 5 short adits totaling less than 125 feet (Miller, 1985). The mineralized zone occurs within Bonanza King and Carrara Formation dolomite and quartzite. It is about 9,000 feet long and 500 feet wide, and generally follows the trace of a bedding-plane thrust that strikes northwest and dips northeast. Individual sulfide veins are oriented at various attitudes and are from a few feet to tens of feet apart; mostly a few inches thick, but some, where stoped, may have been several feet wide (Miller, 1985). Common disseminated sulfide minerals include galena and pyrite, with oxides developed in the weathered zone. Although no production is recorded, the extent of stoping indicates that a minor amount of ore could have been produced.

## Areas Classified as MRZ-3b(h)

*Greenwater Valley Area, MRZ-3b (h-7)*: In the preceding section, two areas adjacent to Greenwater Valley have been classified as MRZ-3a (h-1) and MRZ-3a (h-2) respectively. Both of these areas possess similar styles and characteristics of hydrothermal mineralization. This similarity has formed the basis for classifying the adjoining alluviated areas of Greenwater Valley as MRZ-3b (h-7).

The system of copper-bearing barite veins exposed in the Greenwater Mining District can, in many cases, be traced continuously in Tertiary intrusive rocks until these rocks disappear beneath Quaternary alluvium. Similar relationships exist in many of the prospected copper bearing barite veins exposed along the eastern side of Greenwater Valley where vein systems appear to be continuous in scoriaceous volcanic rocks until covered by alluvium. Thus, evidence indicates that the local faults, breccia zones, and fracture zones are the immediate control of mineralization and that the zones project into and in all probability, exist under, the relatively thin veneer of Quaternary alluvium that mantles Greenwater Valley.

Drewes (1963), advanced the following explanation for the Greenwater mineralization: these relations seem to be significant:(a) most mineralized rocks are rhyolitic intrusive rocks near their contact with monzonitic rocks, or are in the monzonitic rock near the volcanic rocks; (b) all the copper minerals in the volcanic rocks, and probably including those from the shafts that reach depths of 300-500 feet, are secondary; (c) the only copper sulfides occur in monzonite or in older rocks near monzonite. An explanation of these relations is that the primary copper is disseminated in the monzonite. Following primary mineralization, copper was moved upward and deposited as silicates and carbonates in the rhyolitic rocks during or after their intrusion. Faults, which may also have localized the rhyolitic intrusive bodies and were channels for relatively early silica-bearing fluids and relatively late copper-bearing and barium-bearing fluids. Local faults, breccia zones, and fracture zones are the immediate controls of mineralization. According to this explanation the primary mineralization is associated with the monzonitic rocks of early to middle Tertiary age, and the secondary mineralization is younger than these rocks, perhaps with particularly abundant movement during Miocene or earlier Tertiary time when the rhyolitic rocks intruded the monzonitic rocks.

Two alternate explanations may be visualized from the available evidence: first, in the situation just described, primary mineralization emplaced copper sulfides at the top of the monzonite stock; that part largely eroded away during early Tertiary time. During this erosion the copper minerals were altered and, in part, transported downward, always remaining a step ahead of complete removal by erosion. Alternately, the mineralization may be entirely contemporaneous with, or slightly older than, the intrusion of the other volcanics. Some of the host rocks were mineralized near the intrusions, and sulfide deposition and preservation were favored by the composition or greater depth of the monzonite and metadiorite.

The potential economic implication of the first explanation is substantial, for it suggests the presence of a porphyry copper deposit. It may be sufficient to justify the cost of a preliminary geochemical investigation to determine the extent of the association of copper with the monzonite or with the rhyolitic intrusive rocks, and geophysical prospecting to extend the gravity anomaly and to determine the depth of fill over monzonitic rocks in Greenwater Valley.

*Shadow Mountain Area, MRZ-3b (h-8)*: Two groups of workings, 6,000 feet apart, exist on the west and northeast flanks of Shadow Mountain. The western group consists of four small pits and one adit about 35 to 40 feet long, and the northeast group consists of 3 small pits. Secondary copper minerals, principally malachite and azurite with minor blebs of copper sulfides discontinuously stain a 5 to 15 feet thick arkosic quartzite (Wood Canyon Formation) that strikes northeasterly and dips 20° to 30°SE. Mineralization appears to be stratabound within the quartzite and, based upon this premise and the possible continuity of mineralization between the two groups of prospects, Miller (1985) estimated an inferred copper resource of 6,000,000 tons at a grade of 1.1 percent copper.

*Central Resting Spring Range, MRZ-3b$^{(h-9)}$*: The Baxter Mine Area ,MRZ-3a$^{(h-3)}$, lies along a mineralized zone that has a length of approximately 9,000 feet along strike. Irregular, pod shaped mineralized masses and vein fillings, which occur along shears, breccia zones, and fractures near or between thrust faults, have developed in dolomites and quartzites of the Bonanza King and Stirling Formations. Sulfide minerals consist of galena, chalcopyrite, pyrite, and sphalerite, with secondary oxides, carbonates, and silicates developed in the oxidized zone. A gossan zone with an abundance of iron oxides is prevalent in the area of the main workings and has developed to a lesser degree along a northerly trend.

Interpretation of Landsat imagery (Raines, 1985) has revealed a large area lying astraddle the central Resting Spring Range that possesses the unique spectral reflectance properties of undifferentiated ferric oxides. Thus, this area has been classified MRZ-3b$^{(h-9)}$, because of the limonitic hydrothermal alteration halo which, in turn, has been demonstrated to be, in part, correlative with an area of known sulfide mineralization.

*High Chicago Mine Area, MRZ-3b$^{(h-10)}$*: The High Chicago Mine, classified MRZ-3a$^{(h-6)}$, lies along a mineralized zone which generally follows the trace of a northwest-striking, northeast-dipping, bedding-plane thrust. This zone, which is 9,000 feet long and 500 feet wide, is enclosed by dolomites of the Bonanza King and Carrara Formations. Common sulfides include galena and pyrite, with oxides developed in the weathered zone. A moderately developed gossan zone is associated with the main mineralized zone and, to a lesser extent, the surrounding area.

Interpretation of Landsat imagery (Raines, 1985) has revealed the presence of an elliptical shaped area of hematization lying on the down-dip extension of the High Chicago trend which has been classified MRZ-3b$^{(h-10)}$

*In Prospect Area, MRZ-3b $^{(h-11)}$*: This area contains three small prospects developed upon minor secondary copper mineralization along or within sheared, fractured quartzite. The In Prospect, developed by pits, trenches, and two small adits, has mineralized zones at or near the sheared, altered contacts of a quartzite bed. Chip samples by USBM personnel revealed no significant metal values; however, select dump samples contained 2.6 to 13.1 percent copper with minor cobalt. Minor production, a few tens of tons, may have been produced (Miller, 1985). The other two prospects, which includes small pits and short adits (less than 10 feet), are developed upon copper-stained fractures in sheared and fractured quartzites. USBM sampling revealed minor gold (.001-.009 oz/ton) values. It is doubtful that the workings supported any production.

*Silver Tip-Junior Prospect Area, MRZ-3b$^{(h-12)}$*: A small area of mineralization lying along the northwestern flank of the Resting Spring Range, due west of the Shadow Mountain copper prospects, contains three prospects that show minor silver assay values (Miller, 1985). Workings consist of twenty-five small pits and one 78 feet-long adit. Mineralization occurs along a sheared, brecciated, argillized contact between dolomite and quartzite and attains widths up to 20 feet. It is doubtful that any production had occurred in the past; USBM sampling showed minor silver and trace gold assay values.

## MINERAL LAND CLASSIFICATION WITHIN WILDERNESS STUDY AREA

Four federal government wilderness study areas (WSAs) are located in and comprise a large portion of the Death Valley SMARA study area, as shown in Figure 5. These WSAs are (1) Nopah Range (BLM No. CDCA-150); (2) Resting Spring (BLM No. CDCA-145); (3) Green water Valley (CDCA-148), and (4) Funeral Mountains (CDCA-143). Preliminary mineral resource evaluation reports prepared by the U.S. Bureau of Mines were available for these WSAs and were utilized as a source of data in the preparation of this report.

Information gathered for the mineral land classification study of the Ash Meadows, Big Dune, Eagle Mountain, Funeral Peak, Pahrump, Ryan, and Stewart Valley 15-minute quadrangles and High Peak 7.5-minute quadrangle have revealed that favorable terranes exist for significant mineral deposits within the Resting Spring Range, Nopah Range and Funeral Mountain WSAs. In order of potential economic importance, these terranes are:

- The western boundary of the Resting Spring WSA encompasses an area lying between Highway 127 and the Resting Spring Range front that is classified MRZ-3b$^{(bo-16)}$ as a potentially favorable area for borate mineralization.
- The Nopah Range, Resting Spring Range, and Funeral Mountain WSA contain extensive deposits of carbonate rocks, classified MRZ-3a$^{(ls-14)}$.
- The Funeral Mountain WSA encompasses an area classified MRZ-3a$^{(b-9)}$ along the eastern range front that is underlain by deposits of bentonite that may be of commercial grade.
- The Resting Spring Range WSA contains three localities, the Baxter Mine area (MRZ-3a$^{(h-3)}$), Silver Tip Mine area (MRZ-3b$^{(h-11)}$) and Copper Hill prospect (MRZ-3b$^{(h-8)}$) and two historic stone quarries located on the flanks of Eagle Mountain .
- The extreme southwestern boundary of the Funeral Mountain WSA encompasses an area classified MRZ-3b$^{(bo-16)}$ lying between Highway 190 and the range front that has potential for borate mineralization.

The potential economic significance of these deposits with regard to the economy and well-being of the region, state, and nation should be weighed against their inclusion into a wilderness area.

## CONCLUDING REMARKS

- Four areas containing borate deposits and three areas containing deposits of zeolites, hectorite, and bentonite, respectively, have been classified for the highest mineral land classification of MRZ-2a. These are areas that are deemed to contain significant deposits or areas in which there is a high likelihood for the presence of significant mineral deposits. The six areas classified MRZ-2a contain significant measured and indicated

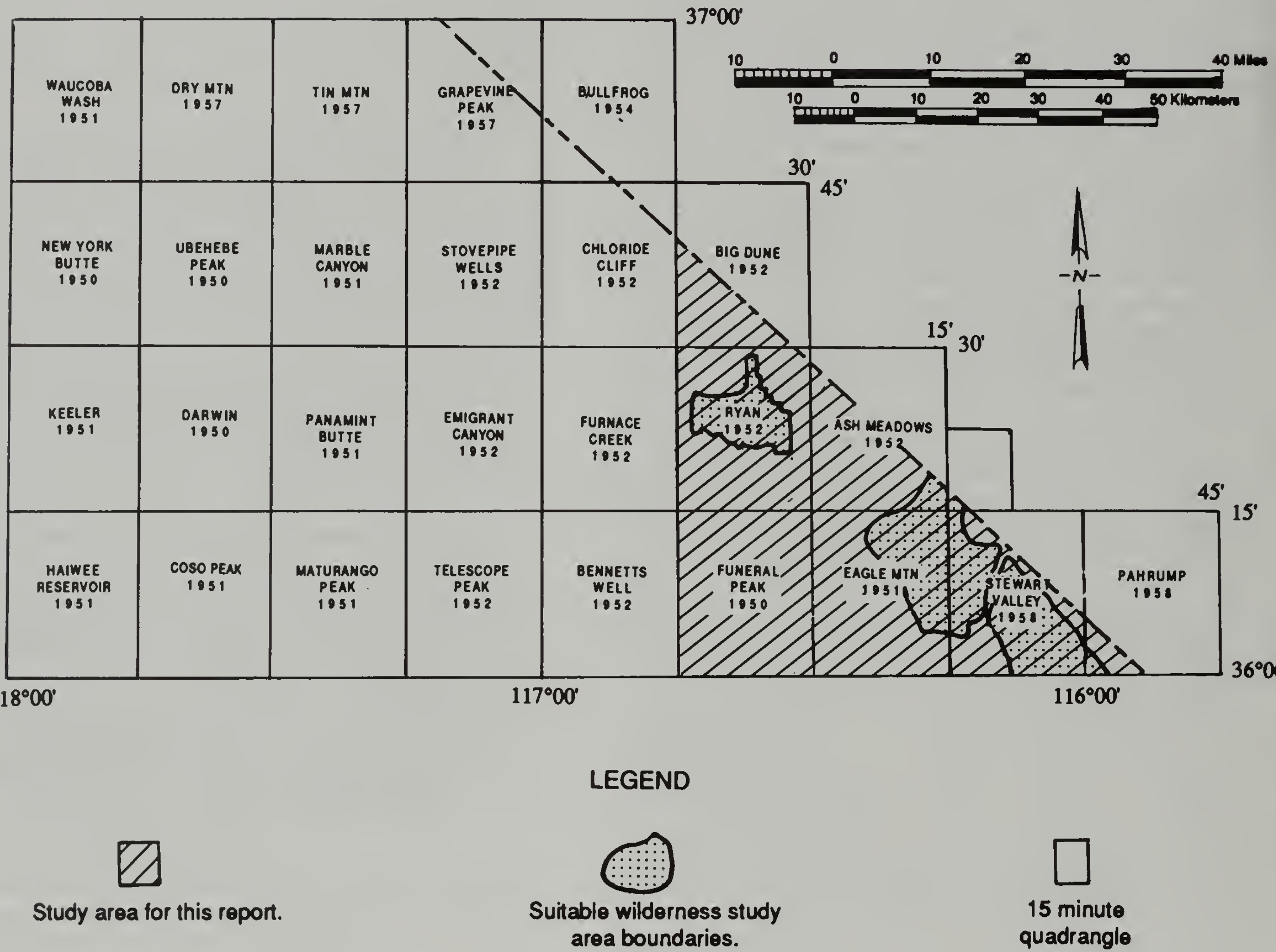


Figure 5. Wilderness study areas in the Death Valley SMARA study area.

resources, while the one area classified MRZ-2b is deemed to contain significant inferred borate resources. Collectively, the four areas classified MRZ-2a for borates, represent the largest known resource of calcium borates outside of the Death Valley National Monument.

- Several areas classified MRZ-3a represent favorable geologic settings or environments for the occurrence of specific industrial minerals. These include: an area lying between Eagle Mountain and Ash Meadows along the west side of the Resting Spring Range which has been found to contain zeolites and bentonitic clays, an area east of the Funeral Mountains known to contain bentonite and hectorite, a deposit of salines located at Alkali Flat, deposits of zeolite, pumice, and perlite located within the Greenwater Range, deposits of carbonate rock in the Nopah, Resting Spring Range, and Funeral Mountains, and a barite deposit along the eastern side of Greenwater Valley.
- Six areas have been classified MRZ-3a as having favorable environments for the occurrence of hydrothermal deposits of silver, lead, zinc, copper, and barite. Some of the most significant of these are: a twenty-mile-long mineralized zone containing silver, gold, copper, and barite, extending from Greenwater southeast to Miller Spring which has potential for a copper porphyry or disseminated gold-silver deposit, the Baxter Mine, High Chicago Mine, and Copper Hill prospects in the Resting Spring Range, and the Nancy-Ann (Shaw) Mine in the Nopah Range. With the exception of the Greenwater District, most of the hydrothermal mineralization found within the study area appears to have an association with and spatially confined to the widespread Mesozoic thrust faults which exists in the Nopah and Resting Spring Ranges.
- Two areas (Ryan to the Amargosa River and Chicago Valley) classified MRZ-3b comprise a large percentage of the study area and are believed to contain undiscovered borate resources which may occur in favorable geologic settings or where mineral discoveries have not yet been made.
- The potential economic significance of all lands classified MRZ-3a, and MRZ-3b with regard to the economy and well being of the region, state, and nation should be weighed against their inclusion into a wilderness area.
- Mineral land classification of the study area provides government agencies with information regarding the presence or likely occurrence of mineral deposits contained beneath land within their jurisdiction. Future land-use policy decisions made for land within the study area can be made with a better understanding of underlying mineral significance or potential. Results of the study may also be useful to individuals and the mineral industry by targeting areas favorable for mineral exploration.

## RECOMMENDATIONS

- Land-use competition in the area represented by the southeast quarter of the Death Valley 1° x 2° sheet has increased dramatically over the last decade, mainly as a result of conflicting interests between proposed federal wilderness lands and mining activities. As a result, local government is faced with land-use conflicts.

  This report may assist in resolving these issues by providing objective mineral information. For example, certain parts of the study area have been classified as containing mineral deposits of economic or potentially economic significance (MRZ-2a and MRZ-2b). Other areas have been recognized as including terranes which provide favorable environments for significant mineral deposits (MRZ-3a and MRZ-3b). These favorable terranes include the Nopah and Resting Spring Ranges and the Funeral Mountains which the Federal government currently considers to be suitable for wilderness designation. In several of these areas, it would be possible to mitigate land use conflicts by adjusting proposed wilderness boundaries to delete areas possessing mineral resource potential, but still maintaining an overall area possessing wilderness characteristics. This is particularly applicable to the western boundary of the Resting Spring WSA; this boundary, instead of being Highway 127 and the old Traction Railroad right-of-way, could be moved eastward to the base of the range front. This boundary would still maintain the Resting Spring Range as proposed wilderness, but would remove the broad, westward-sloping pediment surface which encompasses an area of potential borate mineralization. Local government should consider the contribution that these deposits could make to the economy and well being of the region, and then weigh these considerations against other competitive land-use demands which may preclude access and utilization of the mineral resources.
- Further investigations are desirable in areas classified MRZ-4 in order to better define their mineral potential. Any information gained by the mining industry and made available would be of considerable value to the mineral land classification effort. These lands should then be reclassified accordingly.

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# APPENDIX A

## MINERAL LAND CLASSIFICATION

### NOMENCLATURE

Following are definitions of the nomenclature associated with the California Mineral Land Classification Diagram. It is important to refer to these definitions when studying the different resource categories shown on Figure 3.

**RESOURCE** — A concentration of naturally occurring solid, liquid, or gaseous material in and/or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

**RESERVES** — That part of the reserve base which could be economically extracted or produced at the time of determination. The term *reserves* need not signify that extraction facilities are in place and operative.

*Reserves* include only recoverable materials; thus, terms such as "extractable reserves" and "recoverable reserves" are redundant and are not a part of this classification.

**ORIGINAL RESOURCE** — The amount of a resource before production.

**IDENTIFIED RESOURCES** — Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. *Identified resources* include economic, marginally economic, and subeconomic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into *measured, indicated, inferred*.

**MEASURED RESERVES** — Quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and (or) qualcomput from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

**INDICATED RESERVES** — Quantity and grade and (or) quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

**DEMONSTRATED RESERVES** — A term for the sum of Measured plus indicated reserves.

**INFERRED RESOURCES** — Estimates are based on an assumed continuity beyond measured and(or) indicated resources, for which there is geologic evidence. *Inferred resources* may or may not be supported by samples or measurements.

**MARGINAL RESERVES** — That part of the reserve base which, at the time of determination, borders on being economically producible. The essential characteristic here is . economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technologic factors.

**ECONOMIC** — This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

**SUBECONOMIC RESOURCES** — The part of identified resources that does not meet the economic criteria of reserves and marginal reserves.

**UNDISCOVERED RESOURCES** — Resources, the existence of which are only postulated, comprising deposits that are separate from identified resources. *Undiscovered resources* may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or subeconomic. To reflect varying degrees of geologic certainty, undiscovered resources may be divided into two parts:

**HYPOTHETICAL RESOURCES** — Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about their quality, grade, and quantity, they will be reclassified as identified resources.

**SPECULATIVE RESOURCES** — Undiscovered resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade, and quality, they will be reclassified as identified resources.

# APPENDIX B

## MINERAL DEPOSIT REFERENCES FOR THE NONURBAN SMARA MINERAL LAND CLASSIFICATION

The models used by the California Division of Mines and Geology in mineral land classification of nonurban portions of the state are based upon geologic processes which brought about mineralization. The resulting mineral deposits are grouped into 10 "genetic" classes as outlined below.

1. Magmatic concentration deposits
2. Contact metasomatic deposits
3. Hydrothermal mineral deposits (exclusive of volcanogenic deposits)
4. Exhalative volcanic deposits (volcanogenic)
5. Deposits formed by sedimentation
6. Deposits of bacteriogenic origin
7. Evaporates
8. Residual and mechanical concentrations
9. Deposits formed by metamorphism¡
10. Industrial mineral deposits formed by diverse processes.

Selected general references which discuss the geologic processes involved in formation of each genetic type of mineral deposit is tabulated in this appendix. Additional references are cited in the text for a better understanding and clarification of the formation of specific mineral deposit types.

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3. Wyllie, P.J., editor, 1967, Ultramafic and related rocks: John Wiley and Sons, Inc., New York, 464 p.
4. General references (1-6).


### Contact Metasomatic Mineral Deposits


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### Hydrothermal Mineral Deposits (exclusive of exhalative volcanism)


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2. Garrels, R.M., and Christ, C.L., 1965, Solutions, minerals and equilibria: Freeman, Copper and Company, San Francisco, 450 P.
3. General references (1-6).


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1. General references (1-6).


### Deposits Formed by Metamorphism


1. Winkler, H.G.F., 1979, Petrogenesis of metamorphic rocks (5th edition): Springer-Verlag, New York, 347 p.
2. Miyashiro, A., 1975, Metamorphism and metamorphic belts: John Wiley and Sons, New York, 452 p.
3. Best, M.G., 1982, Igneous and metamorphic petrology: W.H. Freeman and Company, San Francisco, 630 p.
4. General references (1-6).


### Industrial Mineral Deposits


1. General references (1-6).

# APPENDIX C

## GLOSSARY

***Adit***: A horizontal passage from the surface into a mine. Sometimes called a tunnel.

***Aerial photograph***: Any photograph taken from the air, such as a photograph of a part of the Earth's surface taken by a camera mounted in an aircraft.

***Alaskite***: A commonly used term for a granitic rock containing only a few percent of dark minerals. A crystalline-granular plutonic rock characterized by essential alkali feldspar and quartz, and little or no dork component. The term alaskite is used to designate granitoid rocks in which quartz constitutes 20-60% of the felsic minerals and in which the ratio of alkali feldspar to total feldspar is greater than 90 %; i.e. the equivalent of alkali granite.

***Alkali rhyolite***: Fine-grained felsic igneous rock enriched with alkali feldspar.

***Alluvial deposit***: Any sediment deposited by flowing water, as in a river bed, flood plain, or delta.

***Alluvial fan***: A cone-shaped deposit of loose material made by a stream where it issues from a narrow mountain valley upon a plain, a broad valley or meets a slower stream.

***Alteration***: Changes in the chemical or mineralogical composition of a rock, generally produced by weathering or hydrothermal solutions.

***Aluminosilicate***: Any aluminum silicate mineral containing alkali metal or alkaline-earth metal ions, as a feldspar or zeolite.

***Alunite***: A mineral: $KA1_3$, $(S0_4)$ $(OH)_6$ generally occurs as a hydrothermal-alteration product in felspathic igneous rock and is used in the manufacture of alum.

***Amphibole***: A group of dark rock-forming ferromagnesian silicate minerals, closely related in crystal form and composition and having the general formula: $A_{2\text{-}3}B_5(Si, A1)_8O_{22}(0H)_2$ where A = Mg, $Fe^{+2}$, Ca or Na, and B = Mg, $Fe^{+2,}$ $Fe^{+3}$, A1.

***Andesite***: A volcanic rock composed essentially of andesine and one or more mafic constituents.

***Anomaly***: A geological feature, especially in the subsurface, distinguished by geological, geophysical, or geochemical means, which is different from the general surroundings and is often of potential economic value; e.g. a magnetic anomaly.

***Aplite***: A light-colored hypabyssal igneous rock characterized by a fine-grained texture. Aplites may range in composition from granitic to gabbroic, but the term "aplite" with no modifier is generally understood to mean granitic aplite, consisting essentially of quartz, potassium feldspar, and acid plagioclase.

***Arkosic sandstone***: A sandstone in which much feldspar is present.

***Assay***: To analyze the proportions of metals in an ore; to test an ore or mineral for composition, purity, weight or other properties of commercial interest.

***Azurite***: A deep-blue to violet-blue mineral, $Cu_3(C0_8)_2(0H)_2$, which is an ore of copper. A common secondary mineral found in the oxidized zone of copper deposits.

***Back arc Environment***: In plate tectonics, a region that occurs behind a volcanic arc which may show convergence (such as crustal faulting and folding) or divergence (such as crustal thinning and subsidence).

***Banded structure***: An outcrop feature developed in igneous and metamorphic rocks as a result of alternation of layers, stripes, flat lenses, or streaks differing conspicuously in mineral composition and/or texture.

***Barite***: A mineral $BaSO_4$. The principle ore of barium, also used in paints and drilling muds.

***Basalt***: An extrusive or hypabyssal rock composed primarily of calcic plagioclase and pyroxene with or without olivine.

***Basement rock***: The undifferentiated complex of rocks that underlies the rocks of interest in an area.

***Base metal***: A metal commonly used in industry by itself rather than alloyed with other metals. Generally considered to be one of the following: copper, lead, zinc, tin, or mercury.

***Batholith***: A large, generally discordant plutonic igneous mass that has more than 40 square miles (100 $km^2$) of surface exposure and no known floor.

***Bedding***: The arrangement of a sedimentary rock in beds or layers of varying thickness and character.

***Belt***: A zone or band of a particular kind of rock strata exposed on the surface. An elongated area of mineralization.

***Bentonite***: A sedimentary rock formed from the alteration in place of volcanic ash. Largely composed of the clay mineral montmorillonite. The rock commonly has a great ability to absorb water and swell.

***Biotite***: A mineral $K(Mg,Fe^{+2})3\ (A1,Fe^{+3})\ Si_3O_{10}\ (OH)_2$, member of the mica group. A common rock-forming mineral.

***Breccia***: A coarse-grained rock, composed of angular broken rock fragments held together by a mineral cement or in a fine-grained matrix; it differs from conglomerate in that the fragments have sharp edges and unworn corners.

***Brochantite***: An emerald-green to dark green mineral: $CU_4(S04_4)(0H)_6$. It is common in the oxidation zone of copper-sulfide deposits.

***Caldera***: A large, basin-shaped volcanic depression, more or less circular or cirque-like in form, the diameter of which is many times greater than that of the included vent or vents, no matter what the steepness of the walls or form of the floor.

***Cambrian***: The earliest period of the Paleozoic era, thought to have covered the span of time between 570 and 500 million years ago.

***Carbonate rock***: A rock consisting chiefly of carbonate minerals, such as limestone, dolomite, or carbonatite.

***Carbonatite***: A carbonate rock of apparent magmatic origin, generally associated with kimberlites or alkalic rocks.

***Carbon dating***: Carbon 14 dating: A method of determining an age in years by measuring the concentration of carbon-14 remaining in an organic material, usually formerly living matter, but also water bicarbonate, etc. The method is useful in determining ages in the range of 500 to 30,000 or 40,000 years.

***Cenozoic***: An era of geologic time, from the beginning of the Tertiary period to the present. The Cenozoic is considered to have begun about 65 million years ago.

***Chalcanthite***: A blue triclinic mineral: $CuSO_45H_2O$. It is a minor ore of copper.

***Chalcedony***: Cryptocrystalline variety of quartz commonly microscopically fibrous. The material of agate.

***Chalcopyrite***: Copper pyrites. A mineral $CuFeS_2$. An important ore of copper.

***Chert***: A hard, extremely dense or compact, dull to semivitreous, microcrystalline or cryptocrystalline sedimentary rock, consisting dominantly of interlocking crystals of quartz.

***Chert nodule***: A dense, irregular, usually structureless, sometimes fossiliferous diagenetic segregation of chert, ranging from regular disks to large, highly irregular, tuberous bodies frequently occurring distributed through calcareous strata.

***Cinder cone***: A conical hill formed by the accumulation of cinders and other pyroclasts, normally of basaltic or andesitic composition.

***Clastic***: Pertaining to a rock or sediment composed principally of broken fragments that are derived from preexisting rocks or minerals and that have been transported some distance from their places of origin; also said of the texture of such a rock.

***Clay***: A size term denoting particles, regardless of mineral composition, with diameter less than $^1/_{256}$ mm (4 microns). Clay is the term generally reserved for material which is plastic when wet and has no well-developed parting along the bedding planes, although it may display banding.

***Colloid***: A fine-grained material that is held in suspension.

***Colluvium***: A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.

***Complex***: A large-scale field association of assemblages of different rocks of any age or origin, having structural relations so intricately involved or otherwise complicated that the rocks cannot be readily differentiated in mapping.

***Concentrates***: Ore or metal which has been separated from its containing rock or earth.

***Concretion***: A nodular or irregular concentration of mineral matter formed by precipitation from aqueous solution about a nucleus or center in the pores of a sedimentary or fragmental volcanic rock and usually of a composition widely different from that of the rock in which it is found.

***Conformable***: Characterization of strata or stratification typified by an unbroken sequence in which the layers are formed one above the other in parallel order by regular, uninterrupted deposition under the same general conditions; also a description of the contacts (abrupt, gradational, or intercalated) between such strata.

***Conformity***: The mutual and undisturbed relationship between adjacent sedimentary strata that have been deposited in orderly sequence with little or no evidence of time lapses; true stratigraphic continuity in the sequence of beds without evidence that the lower beds were folded, tilted, or eroded before the higher beds were deposited.

***Conglomerate***: A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than 2 mm in diameter (granules, pebbles, cobbles, boulders) set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

***Connate water***: Water entrapped in the interstices of a sedimentary rock at the time of its deposition.

***Contact***: The place or surface where two different kinds of rocks come together.

***Contact aureole***: A zone surrounding an igneous intrusion in which the country rock shows the effects of contact metamorphism.

***Contact metasomatic***: A mass change in the composition of rocks in contact with an invading magma, from which "fluid" constituents are carried out to combine with some of the country-rock constituents to form a new suite of minerals.

***Cordilleras***: A mountain system in western North America, including the Sierra Nevada, Coast Range, Cascade Range, Rocky Mountains, etc. The entire chain of mountain ranges parallel to the Pacific Coast, extending from Cape Horn to Alaska.

***Country rock***: A general term applied to the rock surrounding and penetrated by mineral veins; in a wider sense applied to the rocks invaded by and surrounding an igneous intrusion.

***Craton***: A part of the Earth's crust that has attained stability, and has been little deformed for a prolonged period.

***Cretaceous***: The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.

***Cross-bedding***: A series of inclined bedding planes having some relationship to the direction of current flow, the angle of rest of the sediment and the rate of supply of sediment.

***Crystalline rock:*** An inexact but convenient term designating an igneous or metamorphic rock, as opposed to a sedimentary rock.

***Cuprodescloizite***: A mineral Pb(Cu, Zn) $V0_4$) (OH). It is isomorphous with descloizite

***Dacite***: An extrusive or hypabyssal rock having the same general chemical composition of quartz diorite.

***Deformation***: Any change in the original form or volume of rock masses produced by tectonic forces; folding, faulting, and solid flow are common modes of deformation

***Deposit***: The term mineral deposit or ore deposit is arbitrarily used to designate a natural occurrence of a useful mineral or ore in sufficient extent and degree of concentration to invite exploitation.

***Deposition***: The laying down of potential rock-forming material; sedimentation.

***Descloizite***: A brown to black mineral: Pb(Zn, Cu)($V0_4$) (OH). It is isomorphous with mottramite.

***Deuteric***: Referring to reactions between primary magmatic minerals and the water-rich solutions that separate from the same body of magma at a late stage in its cooling history.

***Devonian***: A period of the Paleozoic era (after the Silurian and before the Mississippian), thought to have covered a span of time between 400 and 345 million years ago.

***Diabase***: An intrusive rock (dike rock) whose main components are labradorite and pyroxene and which is characterized by ophitic texture.

***Dike***: A tabular igneous intrusion that cuts across the bedding or foliation of the country rock.

***Diorite***: A group of plutonic rocks intermediate in composition between felsic and ultramafic types, characteristically composed of dark-colored amphibole (esp. hornblende), acid plagioclase (oligoclase, andesine), pyroxene, and sometimes a small amount of quartz; also, any rock in the group; the approximate intrusive equivalent of andesite.

***Dip***: The angle that a structural surface, e.g. a bedding or fault plane, makes with the horizontal, measured perpendicular to the strike of the structure and in the vertical plane.

***Disseminated sulfide deposit***: A mineral deposit (especially of metals) in which the desired minerals occur, in association with sulfide, as scattered particles in the rock, but in sufficient quantity to make the deposit an ore.

***Dolomite***: A common rock-forming rhombohedral mineral: $CaMg(CO_3)_2$. Dolomite is white, colorless, or tinged yellow, brown, pink, or gray. Dolomite is found in extensive beds as dolomite rock; it is a common vein mineral, and is found in serpentinite and other magnesium rocks.

***Dolomitization***: The process by which limestone is wholly or partly converted to dolomite rock or dolomitic limestone by the replacement of the original calcium carbonate (calcite) by magnesium carbonate (mineral dolomite).

***Dunite***: An ultramafic rock composed almost entirely of olivine, with accessory chromite almost always present.

***Eolian sand***: Sand deposits which have been arranged by the wind.

***Epidote***: A yellowish-green, pistachio-green, or blackish-green mineral: $Ca_2(A1, Fe_3)\,Si_3O_{12}\,(OH)$. It commonly occurs associated with albite and chlorite as formless grains or masses or as crystals in low-grade metamorphic rocks (derived from limestones), or as a rare accessory constituent in igneous rocks, where it represents alteration products of ferromagnesian minerals.

***Epithermal***: A term used to indicate hydrothermal mineralization formed within about 1 kilometer of the Earth's surface and in the temperature range of 50°-200°C, occurring mainly as veins (Park & MacDiarmid, 1970, p. 344).

***Facies***: The aspect, appearance, and characteristics of a rock unit, usually reflecting the conditions of its origin; esp. as differentiating the unit from adjacent or associated units.

***Fanglomerate***: A sedimentary rock which is composed of heterogeneous materials which were originally deposited in an alluvial fan but which since deposition have been cemented into solid rock.

***Fault***: A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture.

***Fault Zone***: A fault that is expressed as a zone of numerous small fractures or of breccia or fault gouge. A fault zone may be as wide as hundreds of meters.

***Fauna***: (a) The entire animal population, living or fossil, of a given area, environment, formation, or time span. Cf: flora. (b) Sometimes incorrectly used to include both the animal and plant fossils of a particular rock unit, i.e. the biota.

***Feldspar***: (a) A group of abundant rock-forming minerals of general formula: MA1 $(A1, Si)_3O_8$, where M = K, Na, Ca, Ba, Rb, Sr, and Fe. Feldspars are the most widespread of any mineral group and constitute 60% of the Earth's crust; they occur as components of all kinds of rocks.

***Felsic volcanic rock***: A mnemonic term derived from (fe) for feldspar, and (s) for silica and applied to light-colored rocks containing an abundance of one or all of these constituents.

***Fenite***: A quartzo-feldspathic rock that has been altered by alkali metasomatism at the contact of a carbonatite intrusive complex. The process is called fenitization. Fenite is mostly alkalic feldspar, with some aegirine, subordinate alkali-hornblende, and accessory sphene and apatite.

***Fenitization***: As generally used today, widespread alkali metasomatism of quartzo-feldspathic country rocks in the environs of carbonatite complexes.

***Ferruginous***: (a) Pertaining to or containing iron, e.g. a sandstone that is cemented with iron oxide. (b) Said of a rock having a red or rusty color due to the presence of ferric oxide (the quantity of which may be very small).

***Fill***: Any sediment deposited by any agent so as to fill or partly fill a valley, sink, or other depression.

***Fire assay***: Any type of assay procedure that requires the heat of a furnace (See assay) .

***Flow breccia***: A breccia that is formed contemporaneously with the movement of a lava flow; the cooling crust becomes fragmented while the flow is still in motion.

***Fold***: A curve or bend of a planar structure such as rock strata, bedding planes, foliation, or cleavage.

***Foliation***: A general term for a planar arrangement of textural or structural features in any type of rock; especially the planar structure that results from flattening of the constituent grains of a metamorphic rock.

***Formation***: A persistent body of igneous, sedimentary, or metamorphic rock, having easily recognizable boundaries that can be traced in the field without recourse to detailed paleontologic or petrologic analysis, and large enough to be represented on a geologic map as a practical or convenient unit for mapping and description.

***Fracture***: A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure by stress. Fracture includes cracks, joints, and faults.

***Gabbro***: A group of dark-colored, mafic intrusive igneous rocks composed principally of basic plagioclase (commonly labradorite or bytownite) and clinopyroxene (augite, with or without olivine and orthopyroxene.

***Gangue***: The valueless rock or mineral aggregates in an ore; that part of an ore that is not economically desirable but cannot be avoided in mining. It is separated from the ore minerals during concentration.

***Garnet***: A group of minerals of formula: $A_3B_2\,(SiO_4)_3$, where A=Ca, Mg, $Fe^{+2,}$ and $Mn^{2,}$ and, B=A1, $Fe^{+3}$, $Mn^{+3}$, $V^{+3}$, and Cr.; occurs as an accessory mineral in a wide range of igneous rocks, but is most commonly found as crystals in metamorphic rocks. Garnet is used as a semiprecious stone and as an abrasive.

***Geosyncline***: Large, generally linear trough that subsided deeply throughout a long period of time in which a thick succession of stratified sediments and possibly extrusive volcanic rocks commonly accumulated.

***Gneiss***: A foliated rock formed by regional metamorphism, in which bands or lenticles of granular minerals alternate with bands or lenticles in which minerals having flaky or elongate prismatic habits predominate. Generally less than 50% of the minerals show preferred parallel orientation. Although a gneiss is commonly feldspar-and quartz-rich, the mineral composition is not an essential factor in its definition. Varieties are distinguished by texture (e.g. augen gneiss), characteristic minerals (e.g. hornblende gneiss), or general composition and/or origins (e.g. granite gneiss).

***Graded bedding***: A type of bedding in which each layer displays a gradual and progressive change in particle size, usually from coarse at the base of the bed to fine at the top. It may form under conditions in which the velocity of the prevailing current declined in a gradual manner.

***Granite***: A plutonic rock in which quartz constitutes 10 to 50 percent of the felsic components and in which the alkali feldspar/total feldspar ratio is generally restricted to the range of 65 to 90 percent.

***Granite gneiss***: A gneiss derived from a sedimentary or igneous rock and having the mineral composition of a granite; a metamorphosed granite.

***Granitic rock***: A term loosely applied to any light-colored coarse-grained plutonic rock containing quartz as an essential component, along with feldspar and mafic minerals.

***Granodiorite***: A group of coarse-grained plutonic rocks intermediate in composition between quartz diorite and quartz monzonite containing quartz, plagioclase (oligoclase or andesine), and potassium feldspar, with biotite, hornblende, or more rarely, pyroxene, as the mafic components; also, any member of that group; the approximate intrusive equivalent of rhyodacite. The ratio of plagioclase to total feldspar is at least two to one. With less alkali feldspar it grades into quartz diorite, and with more alkali feldspar, into granite or quartz monzonite.

***Granophyric***: A textural term applied to generally fine-grained intergrowths of quartz and alkali feldspar in igneous rocks.

***Graywacke***: A dark gray, firmly indurated, coarse-grained sandstone that consists of poorly sorted, angular to subangular grains of quartz and feldspar, with a variety of dark rock and mineral fragments embedded in a compact clayey matrix; having the general composition of slate and containing an abundance of very fine-grained illite, sericite, and chloritic minerals.

***Gypsum***: Alabaster, selenite; satin spar. A mineral, $CaSO_4 2H_2O$. Monoclinic. A common mineral of evaporites. Used in the manufacture of plaster of paris.

***Heap leaching***: A process used for the recovery of copper and gold from weathered ore and material from mine dumps.

***Hectorite***: A lithium-rich clay mineral of the Montmorillonite Group Na $_{33}$(Mg, Li)$_3$ SiO$_4$O$_{10}$(F, OH)$_2$.

***Hematite***: A mineral $Fe_2O_3$. The principal ore of iron.

***High angle fault***: A fault with a dip greater than 45°.

***High grade ore***: Rich ore.

***Hornblende***: A mineral of the amphibole group (Ca, Na)$_{2\text{-}3}$ (Mg, $Fe^{+2}$, $F^{+3}$, A1)$^5$ ( A1, Si)$_8$ O$_{22}$ (OH)$_2$.

***Host rock***: A body of rock that is older than rocks or minerals introduced into it or formed within or adjacent to it; e.g. any rock in which ore deposits occur.

***Hydrated compound***: A mineral compound that is produced by hydration, or one in which water is part of the chemical composition.

***Hydrothermal***: Of or pertaining to hot water, to the action of hot water, such as a mineral deposit precipitated from a hot aqueous solution, with or without demonstrable association with igneous processes.

***Hydrothermal alteration***: Alteration of rocks or minerals by the reaction of hydrothermal water with preexisting solid phases.

***Hypabyssal***: Pertaining to an igneous intrusion or to the rock of that intrusion whose depth is intermediate between that of abyssal or plutonic and the surface.

***Hypersaline solution***: Excessively saline, with a salinity substantially greater than that of normal sea water.

***Hypothermal***: A term referring to hydrothermal mineral processes that formed at great depth and in the temperature range of 300°-500°C.

***Igneous rock***: A rock or mineral that solidified from molten or partly molten material, i.e. from a magma.

***Induration***: The hardening of a rock or rock material by heat, pressure, or introduction of cementing material; esp. the process by which relatively consolidated rock is made harder or more compact.

***Industrial mineral***: Any rock, mineral, or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels, and gemstones; one of the nonmetallics.

***Interbedded***: Said of beds lying between or alternating with others of different character, especially said of rock material laid down in sequence between other beds.

***Intermediate volcanic rock***: An igneous rock that is transitional between mafic and felsic in composition and generally having a silica content of 54 to 65 percent; e.g. andesite.

***Intrusive rock***: A rock that consolidated from magma beneath the surface of the earth.

***Island arc***: A chain of islands, e.g. the Aleutians, rising from the deep-sea floor and near to the continents.

***Isotope***: One of two or more species of the same chemical element, i.e. having the same number of protons in the nucleus, but differing from one another by having a different number of neutrons.

***Jurassic***: The second period of the Mesozoic era (after the Triassic and before the Cretaceous), thought to have covered the span of time between 190 and 135 million years ago.

***Kaolin***: A clay, mainly hydrous aluminum silicate, from which porcelain may be made.

***Kaolinization***: Replacement or alteration of minerals, especially feldspars and micas, to form kaolin as a result of weathering or hydrothermal alteration.

***Lacustrine deposit***: Deposits pertaining to, produced by, or formed in a lake or lakes.

***Lakebeds:*** The flat to gently undulating ground underlain by fine-grained sediments deposited in a former lake; bottom of a lake.

***Landslide***: A general term covering a wide variety of mass-movement land-forms and processes involving the downslope transport, under gravitational influence, of soil and rock material en masse.

***Lens:*** A body of ore or rock, thick in the middle and thin at the edges; similar to a double convex lens.

***Limestone***: A bedded sedimentary deposit consisting chiefly of calcium carbonate ($CaC0_3$).

***Limonite***: A field term for a group of brown, amorphous, naturally occurring, hydrous ferric oxides; may consist of the minerals goethite, hematite, and lepidocrocite.

***Lithologic terrane***: The area or surface over which a particular rock or group of rocks is prevalent.

***Lithology***: The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

***Mafic***: A term to signify an igneous rock composed chiefly of one or more ferromagnesian, dark-colored minerals in its mode; also, used to signify such minerals.

***Magma***: Naturally occurring mobile rock material, formed within the Earth and capable of intrusion and extrusion, from which igneous rocks are thought to have been derived through solidification and related processes.

***Magnetite:*** Magnetic iron ore. A mineral of the spinel group, $Fe_3O_4$. An important ore of iron.

***Malachite***: A mineral, $Cu_2 (C0_3) (OH)_2$. A typical alteration product in the oxidized zone of copper sulfide deposits.

***Marble***: A metamorphic rock composed essentially of calcite and/or dolomite.

***Massive***: Of homogeneous structure, without stratification, flow-banding, foliation, schistosity, and the like; said of the structure of some rocks.

***Matrix***: Finer-grained material enclosing, or filling the interstices between, the larger grains or particles of a sediment or sedimentary rock.

***Mesozoic***: An era of geologic time, from the end of the Paleozoic to the beginning of the Cenozoic, or from about 225 to about 65 million years ago.

***Metamorphic rock***: Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.

***Metasedimentary rock***: A sediment or sedimentary rock that shows evidence of having been subjected to metamorphism.

***Metasomatic replacement***: The processes by which one mineral is replaced by another of different chemical composition owing to reactions set up by the introduction of material from external sources.

***Metavolcanic rock***: Metamorphosed volcanic rock.

***Meteoric water***: (a) Pertaining to water of recent atmospheric origin. (b) Pertaining to, dependent on, derived from, or belonging to the Earth's atmosphere; e.g. "meteoric erosion" caused by rain, wind, or other atmospheric forces.

***Mica*** A mineral group, consisting of phyllosilicates with sheetlike structures. The general formula of the group is (K, Na, Ca) (Mg, Fe, Li, A1)$_{2\text{-}3}$ (A1, Si)$_4$O$_{10}$ (OH),F)$_2$.

***Mica schist***: A schist whose essential constituents are mica and quartz, and whose schistosity is mainly due to parallel arrangement of mica flakes.

***Migmatite***: A composite rock composed of igneous or igneous-appearing and/or metamorphic materials, which are generally distinguishable megascopically.

***Mineral***: A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.

***Mineral deposit***: A mass of naturally occurring mineral material, e.g. metal ores or nonmetallic minerals, usually cf economic value, without regard to mode of origin.

***Mineralization***: The process or processes by which a mineral or minerals are introduced into a rock, resulting in a valuable or potentially valuable deposit.

***Miogeosyncline***: A geosyncline in which volcanism is not associated with sedimentation; the non-volcanic aspect of an orthogeosyncline, located near the craton.

***Mississippian***: A period of the Paleozoic era (after the Devonian and before the Pennsylvanian), thought to have covered the span of time between 345 and 320 million years ago.

***Monzonite***: A granular plutonic rock containing approximately equal amounts of orthoclase and plagioclase and thus intermediate between syenite and diorite.

***Mountain range***: A single, large mass consisting of a succession of mountains or narrowly spaced mountain ridges, with or without peaks, closely related in position, direction, formation, and age.

***Nodule***: Small more or less rounded body generally somewhat harder than the enclosing sediment or rock matrix.

***Normal fault***: A fault at which the hanging wall has been depressed, relative to the footwall.

***Opalite***: An impure, colored variety of common opal.

***Open pit mine***: Surficial mining, in which the valuable rock is exposed by removal of overburden.

***Ordovician***: The second earliest period of the Paleozoic era (after the Cambrian and before the Silurian), thought to have covered the span of time between 500 and 440 million years ago.

***Ore deposit***: The naturally occurring material from which a mineral or minerals of economic value can be extracted at a profit.

***Orogeny***: The process by which structures within fold-belt mountainous areas were formed, including thrusting, folding, and faulting in the outer and higher layers, and plastic deformation, metamorphism, and plutonism in the inner and deeper layers.

***Orthoclase***: A mineral, a member of the feldspar group. Composition KA1Si$_3$O$_8$. A common mineral of granitic rocks.

***Orthogneiss***: A term used to denote a gneiss derived from an igneous rock.

***Outcrop***: The exposure of bedrock or strata projecting through the overlying cover of detritus and soil.

***Overthrust fault***: A low-angle thrust fault of large scale, with displacement generally measured in kilometers.

***Overturned fold***: A fold, or limb of a fold, that has tilted beyond the perpendicular. Sequence of strata thus appears reversed.

***Oxide*** A mineral compound characterized by the linkage of oxygen with one or more metallic elements.

***Paleocene***: An epoch of the early Tertiary period, after the Gulfian of the Cretaceous period and before the Eocene.

***Paleozoic***: An era of geologic time, from the end of the Precambrian to the beginning of the Mesozoic, or from about 570 to about 225 million years ago.

***Pediment***: A broad, gently sloping rock-floored erosion surface or plain of low relief, typically developed by subaerial agents (including running water) in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment, and underlain by bedrock (occasionally by older alluvial deposits) that may be bare but are more often partly mantled with a thin discontinuous veneer of alluvium derived from the upland masses and in transit across the surface.

***Pegmatite***: An exceptionally coarse-grained igneous rock, with interlocking crystals, usually found as irregular dikes, lenses, or veins, esp. at the margins of batholiths.

***Pennsylvanian***: A period of the Paleozoic era (after the Mississippian and before the Permian), thought to have covered the span of time between 320 and 280 million years ago.

***Peridotite***: A general term for a coarse-grained plutonic rock composed chiefly of olivine with or without other mafic minerals such as pyroxenes, amphiboles, or micas, and containing little or no feldspar.

***Permian***: The last period of the Paleozoic era (after the Pennsylvanian), thought to have covered the span of time between 280 and 224 million years ago.

***Petro-tectonic event***: A large scale geologic or rock-forming system viewed in terms of plate motion (plate tectonics).

***Phenocryst***: A relatively large, conspicuous crystal in a porphyritic rock.

***Phyllite***: A metamorphosed rock, intermediate in grade between slate and mica schist .

***Plate tectonics***: A theory of global tectonics in which the lithosphere is divided into a number of plates whose pattern of horizontal movement is that of torsionally rigid bodies that interact with one another at their boundaries, causing seismic and tectonic activity along these boundaries.

***Pliocene***: An epoch of the Tertiary period, after the Miocene and before the Pleistocene.

***Pluton***: An igneous intrusion.

***Polymetallic***: A mineral deposit that contains economically important quantities of three or more metals.

***Poorly sorted***: Said of a clastic sediment or of a cemented detrital rock that is not sorted or that consists of particles of many sizes mixed together in an unsystematic manner.

***Porous rock***: Rock containing voids, pores, interstices, or other openings which may or may not interconnect.

***Porphyroblast***: A psuedoporphyritic crystal in a rock produced by metamorphic recrystallization

***Porphyry***: An igneous rock of any composition that contains conspicuous phenocrysts in a fine-grained groundmass.

***Potassium feldspar***: A mineral member of the feldspar group containing a high potassium content.

***Precambrian***: All rocks formed before the Cambrian.

***Precious metal***: A general term for gold, silver, or any of the minerals of the platinum group.

***Prospect***: An area that is a potential site of a mineral deposit. A prospect is distinct from a mine in that it is non-producing.

***Pumice***: A light-colored vesicular glassy rock formed by volcanism, commonly having the composition of rhyolite.

***Pyrite***: A common, pale-bronze or brass-yellow mineral, $FeS_2$, which often contains small amounts of other metals. Pyrite is the most widespread and abundant of the sulfide minerals and occurs in all kinds of rocks. Pyrite is an important ore of sulfur; it is sometimes mined for the associated gold and copper.

***Pyroclastic***: Pertaining to clastic rock material formed by volcanic explosion or aerial expulsion from a volcanic vent.

***Quartzite***: A granoblastic metamorphic rock consisting mainly of quartz and formed by recrystallization of sandstone or chert by either regional or thermal metamorphism.

***Quartz monzonite***: An igneous rock containing major plagioclase, orthoclase, and quartz with minor biotite and hornblende and accessory apatite, zircon and opaque oxides.

***Quart trachyte***: A fine-grained igneous rock consisting mostly of alkali feldspar, with normative quartz between 5 and 20 percent; the volcanic equivalent of quartz syenite.

***Quaternary***: The latest period of time in the stratigraphic column, 0-2 million years ago.

***Radiometric dating***: Pertaining to the measurement of geologic time by the study of parent and/or daughter isotopic abundances and known disintegration rates of the radioactive parent isotopes.

***Rapakivi***: A texture observed in igneous and metamorphic rocks, in which rounded crystals of potassium feldspar, a few centimeters in diameter, are surrounded by a mantle or rim of sodium feldspar in a finer-grained matrix, usually composed of quartz and colored minerals.

***Rare earths'***: Oxides of a series of fifteen metallic elements that include elements with atomic numbers ranging from 57 through 71 and three other elements: yttrium, thorium, and scandium. These elements are not especially rare in the Earth's crust, but concentrations are. The rare earth's are constituents of certain minerals, esp. monazite, bastnaesite, and xenotime.

***Regional deformation***: A general term for the process of folding, faulting, shearing, compression or extension of the rocks affecting an extensive region as a result of various earth forces.

***Regional metamorphism***: A general term for metamorphism affecting an extensive region, as opposed to local metamorphism that is effective only in a relatively restricted area.

***Replacement***: The process of practically simultaneous capillary solution and deposition, by which a new mineral of partly or wholly differing chemical composition may grow in the body of an old mineral or mineral aggregate.

***Retrograde metamorphism***: A type of polymetamorphism by which metamorphic minerals of a lower grade are formed at the expense of minerals characteristic of a higher grade of metamorphism, a readjustment necessitated by a change in physical conditions, e.g. lowering of temperature.

***Rhyolite***: A group of extrusive igneous rocks, typically porphyritic and commonly exhibiting flow texture, with phenocrysts of quartz and alkali feldspar in a glassy to cryptocrystalline groundmass; also, any rock in that group; the extrusive equivalent of granite.

***Roof pendant***: A downward projection of older rock into an igneous intrusion.

***Schist***: A strongly foliated crystalline rock, formed by dynamic metamorphism, that can be readily split into thin flakes of slabs due to the well-developed parallelism of more than 50 percent of the minerals present, particularly those of lamellar or elongate prismatic habit, e.g. mica or hornblende.

***Sedimentary rock***: A rock resulting from the consolidation of loose sediment that has accumulated in layers; e.g. a clastic rock (such as conglomerate or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice.

***Serpentine***: A rock consisting almost wholly of serpentine-group minerals, e.g. antigorite and chrysotile or lizardite, derived from the alteration of ferromagnesian silicate minerals such as olivine and pyroxene.

***Sericitic alteration***: A type of hydrothermal alteration which results in a complete loss of soda and a large gain in silica, potash, perhaps pyrite and other substances. The typical product of complete sericization is a finely granular aggregate of sericite, quartz, pyrite, and calcite, which usually forms a very incompetent rock.

***Shaft***: A vertical or inclined excavation through which a mine is worked.

*Shale*: A fine-grained detrital sedimentary rock, formed by the consolidation (esp. by compression) of clay, silt, or mud.

*Shear zone*: A tabular zone of rock that has been crushed and brecciated by many parallel fractures due to shear strain. Such an area is often mineralized by ore-forming solutions.

*Shelf*: A stable cratonic area that was periodically flooded by shallow marine waters and received a relatively thin, well-winnowed cover of sediments.

*Shonkinite*: A dark-colored syenite composed chiefly of augite and alkali feldspar, and possibly containing olivine, hornblende, biotite, and nepheline.

*Siderite*: An iron carbonate with a composition of $FeCO_3$.

*Siliceous*: Said of a rock containing abundant silica.

*Silicified*: To be replaced by silica, generally resulting in the formation of fine-grained quartz, chalcedony, or opal, which may fill pores and replace existing minerals.

*Sill*: A tabular igneous intrusion that parallels the planar structure of the surrounding rock.

*Sillimanite*: A brown, gray, pale-green, or white orthorhombic mineral: $Al_2SiO_5$. It is trimorphous with kyanite and andalusite. Sillimanite occurs in long, slender, needlelike crystals often found in wisplike or fibrous aggregates in schists and gneisses; it forms at the high temperature or pressure in a regionally metamorphosed sequence and is characteristic of the innermost zone of contact-metamorphosed sediments.

*Silt*: A rock or mineral particle in the soil, having a diameter in the range of 0.002-0.05 mm; prior to 1937, the range was 0.005-0.05 mm. The diameter range recognized by the International Society of Soil Science is 0.002-0.02 mm. A soil containing more than 80% silt-size particles, less than 12 percent clay, and less than 20 percent sand.

*Siltstone*: An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility. Siltstone is regarded as a rock whose composition is intermediate between those of sandstone and shale and of which at least two-thirds is material of silt size; it tends to be flaggy, containing hard, durable, generally thin layers, and often showing various primary current structures.

*Skarn*: As used by Fennoscandian geologists, an old Swedish mining term for silicate gangue (amphibole, pyroxene, garnet, etc.) of certain iron-ore and sulfide deposits of Archean age, particularly those that have replaced limestone and dolomite. Its meaning has been generally expanded to include lime-bearing silicates, of any geologic age, derived from nearly pure limestone and dolomite with the introduction of large amounts of Si, Al, Fe and Mg. In American usage the term is more or less synonymous with tactite.

*Sorting*: The dynamic process by which sedimentary particles having some particular characteristic (such as similarity of size, shape, or specific gravity) are naturally selected and separated from associated but dissimilar particles by the agents of transportation (esp. by the action of running water).

*Stratigraphy*: The branch of geology concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties - with all characters and attributes of rocks as strata.

*Strike*: The direction or trend taken by a structural surface, e.g. a bedding or fault plane, as it intersects the horizontal.

*Stringer*: A mineral veinlet or filament, usually one of a number, occurring in a discontinuous subparallel pattern in host rock.

*Structure*: The general disposition, attitude, arrangement or relative positions of the rock masses of a region or area; the sum total of the structural features of an area, consequent upon such deformational processes as faulting, folding, and igneous intrusion.

*Subsidence*: The sudden sinking or gradual downward settling of the Earth's surface with little or no horizontal motion. The movement is not restricted in rate, magnitude, or area involved.

*Syenite*: A group of plutonic rocks containing alkali feldspar (usually orthoclase, microcline, or perthite), a small amount of plagioclase (less than in monzonite), one or more mafic minerals (esp. hornblende), and quartz, if present, only as an accessory; also, any rock in that group; the intrusive equivalent of trachyte. With an increase in the quartz content, syenite grades into granite.

*Tailings*: Those portions of washed or milled ore that are regarded as too poor to be treated further, as distinguished from the concentrates, or material of value.

*Talc*: An extremely soft, light green or gray monoclinic mineral: $Mg_3Si_4O_{10}(OH)_2$. It has a characteristic soapy or greasy feel and it is easily cut with a knife. Talc is a common secondary mineral derived by alteration (hydration) of nonluminous magnesium silicates (such as olivine, enstatite, and tremolite) in basic igneous rocks, or by metamorphism of dolomite rocks, and it usually occurs in foliated, granular, or fibrous masses.

*Tectonics*: A branch of geology dealing with the broad architecture of the outer part of the Earth, that is, the regional assembling of structural or deformational features, a study of their mutual relations, origin, and historical evolution.

*Terrane*: The area or surface over which a particular rock or group of rocks is prevalent.

*Tertiary*: A period of time between 65 and three to two million years ago.

*Texture*: The general physical appearance or character of a rock, including the geometric aspects of, and the mutual relations among, its component particles or crystals; e.g. the size, shape, and arrangement of the constituent elements cf a sedimentary rock, or the crystallinity, granularity, and fabric of the constituent elements of an igneous rock.

***Thrust fault***: A fault with a dip of 45° or less over much of its extent, on which the hanging wall appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature.

***Trachyte***: A group of fine-grained, generally porphyritic, extrusive rocks having alkali feldspar and minor mafic minerals (biotite, hornblende, or pyroxene) as the main components, and possibly a small amount of sodic plagioclase; also, any member of that group; the extrusive equivalent of syenite.

***Triassic***: The first period of the Mesozoic era (after the Permian of the Paleozoic era, and before the Jurassic), thought to have covered the span of time between 225 and 190 million years ago.

***Trough***: Any long, narrow depression in the Earth's surface such as one between hills or with no surface outlet for drainage.

***Tuff***: A general term for rock formed from consolidated pyroclastic ejecta.

***Turquoise***: A triclinic mineral with a composition of $CuA1_6(PO_4)_4(OH)_8\ 4H_2O$.

***Ultramafic rock***: A general name for rock that includes, dunite, peridotite, pyroxenite, and kimberlite, and komatite.

***Unconformity***: A substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic succession, such as an interruption in the continuity of a depositional sequence of sedimentary rocks or a break between eroded igneous rocks and younger sedimentary strata. It results from a change that caused deposition to cease for a span of time, and it implies erosion with loss of the previously formed record.

***Unconsolidated***: To be loosely arranged or unstratified.

***Vanadate***: A mineral compound characterized by pentavalent vanadium and oxygen in the anion.

***Vein***: A thin sheetlike igneous intrusion into a fissure.

***Veneer***: A weathered or otherwise altered coating on a rock surface, e.g. desert varnish.

***Vesicular***: Said of the texture of a rock, esp. a lava, characterized by abundant vesicles formed as a result of the expansion of gases during the fluid stage of the lava.

***Volcanic rock***: Finely crystalline or glassy igneous rock resulting from volcanic action at or near the Earth's surface, either ejected explosively or extruded as lava; e.g. basalt.

***Vuggy***: Numerous small cavities in a vein or in rock usually lined with crystals of mineral composition from enclosing rock.

***Weathering***: The physical disintegration and chemical decomposition of rock that produces an in-situ mantle of waste and prepares sediments for transportation.

***Welded tuff***: A glass-rich pyroclastic rock that has been indurated by the welding together of its glass shards under the combined action of the heat retained by particles, the weight of overlying material, and hot gases.

***X-ray diffractionanalysis***: Use of X-rays by Laue method, by X-ray spectrometry, crystal rotation, or powder rotation method to photograph and establish lattice structure of crystals. This gives identification of species and elucidates the structural bonding of the constituents elements.

***Zeolite***: A large group of white to colorless (sometimes red or yellow) hydrous aluminosilicates that are analogous in composition to the feldspars. Includes the minerals Natrolite, Heulandite, Analcime, Chabazite, Stilbite, Mesolite, Scocecite, Phillipsite, Laumontite, Mordenite, Clinoptilolite, Erionite and Harmotome.

MINERAL LAND CLASSIFICATION OF THE ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP, AND STEWART VALLEY 15-MINUTE QUADRANGLES AND HIGH PEAK 7.5-MINUTE QUADRANGLE, INYO COUNTY, CALIFORNIA

SPECIAL REPORT 167

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-PETE WILSON, GOVERNOR
THE RESOURCES AGENCY-DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-EDWARD G. HEIDIG, DIRECTOR

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PLATE 1

STATE OF CALIFORNIA-PETE WILSON, GOVERNOR
THE RESOURCES AGENCY-DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-EDWARD G. HEIDIG, DIRECTOR

# GEOLOGIC MAP

## OF THE

## ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP & STEWART VALLEY 15-MINUTE QUADRANGLES

## AND

## HIGH PEAK 7 1/2-MINUTE QUADRANGLE

Compiled by

GARY C. TAYLOR

1986

### MINERAL DEPOSIT SYMBOLS

**METALLIC**

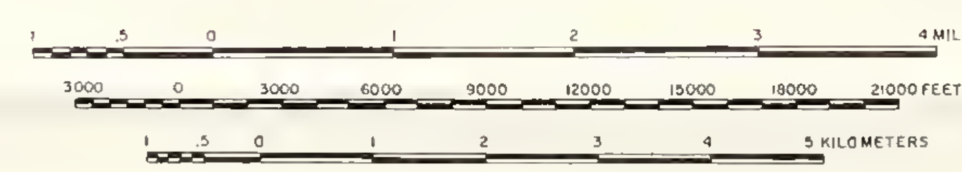
- Gold, Placer
- Gold, Lode
- Copper
- Lead, Silver, Zinc

**NON-METALLIC**

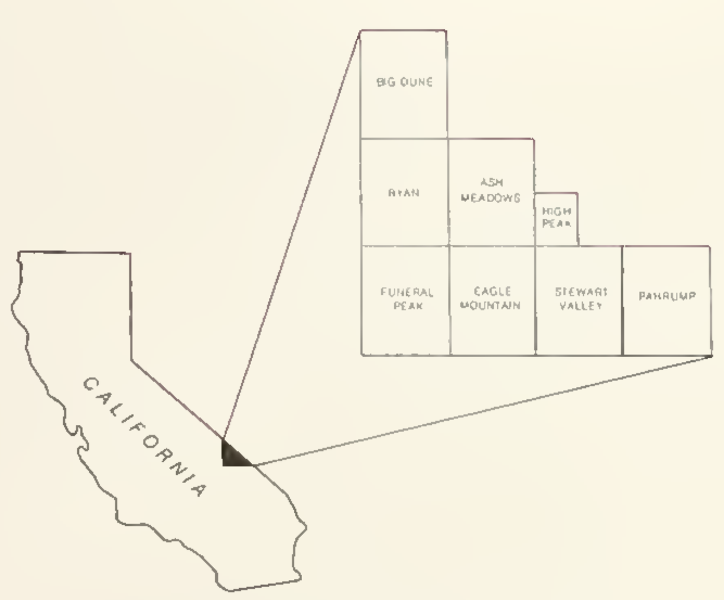
- C Clay
- Si Silica/Quartzite (si)
- Z Zeolite
- B Borate
- Pumice
- S Stone

- Field visited
- 23 Mine Index Number
- Orientation of Deposit


DECLINATION




CONTOUR INTERVAL 80 FEET



Location Map and Index of Topographic Maps

### EXPLANATION

**Sedimentary and Metasedimentary Rocks**

CENOZOIC — QUATERNARY
- Recent: Qal — Alluvium
- Ql — Quaternary lake deposits
- Pleistocene: Qc — Pleistocene nonmarine
- QP — Plio-Pleistocene nonmarine

CENOZOIC — TERTIARY
- Pliocene: Pc — Undivided Pliocene nonmarine
- Undivided: Tc — Tertiary nonmarine

MESOZOIC

PALEOZOIC
- Undivided: P — Paleozoic marine (ls=limestone or dolomite)
- Carboniferous: CP — Pennsylvanian marine
- CM — Mississippian marine
- Devonian: D — Devonian marine
- Silurian: S — Silurian marine

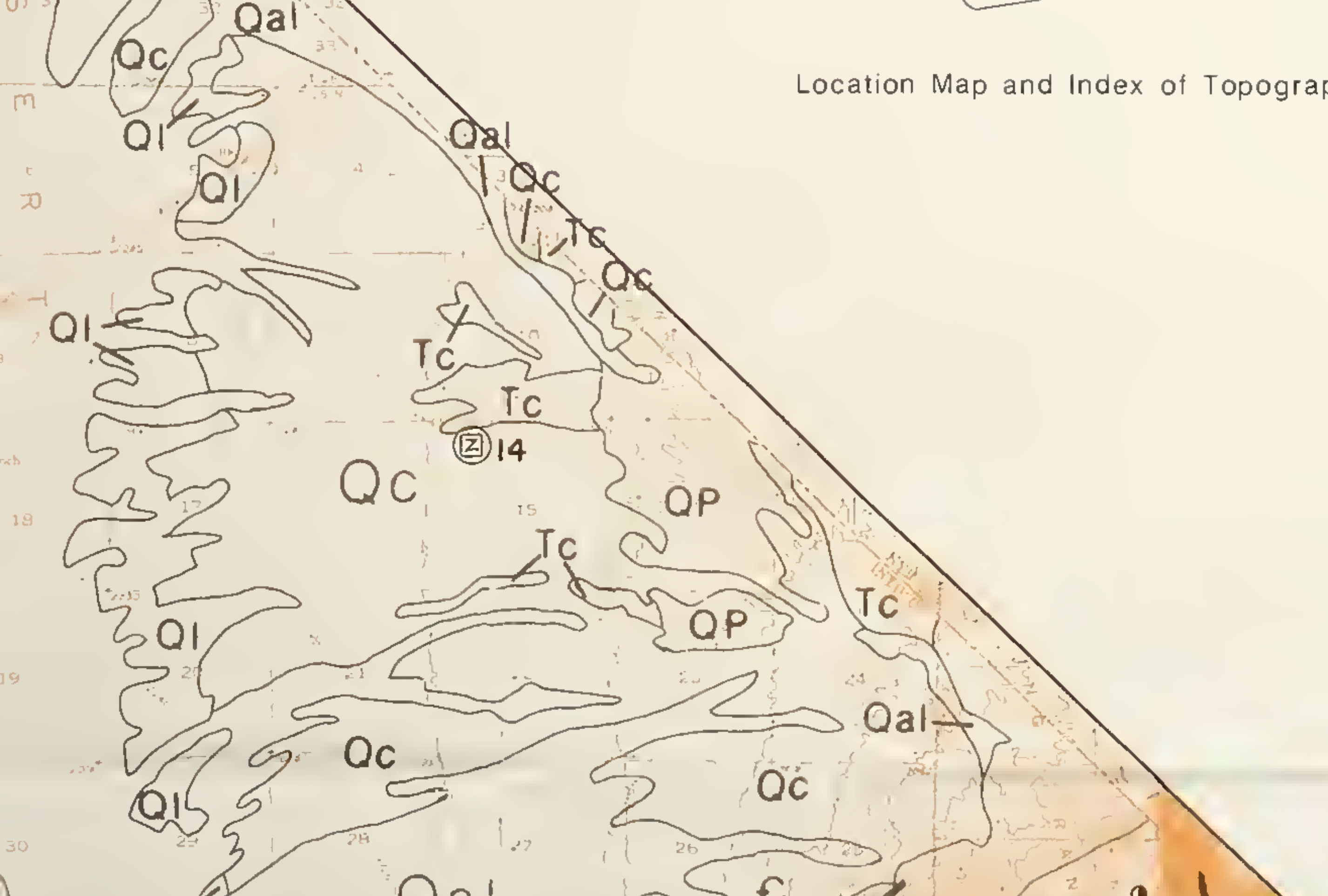
**Volcanic Rocks**

- Quaternary and/or Pliocene cinder cones
- Pv — Pliocene volcanic. $Pv^r$-rhyolite; $Pv^a$-andesite; $Pv^b$-basalt; $Pv^p$-pyroclastic rocks
- Tv — Tertiary volcanic: $Tv^r$-rhyolite; $Ti^a$-andesite; $Ti^b$-basalt $Ti^p$-pyroclastic rocks

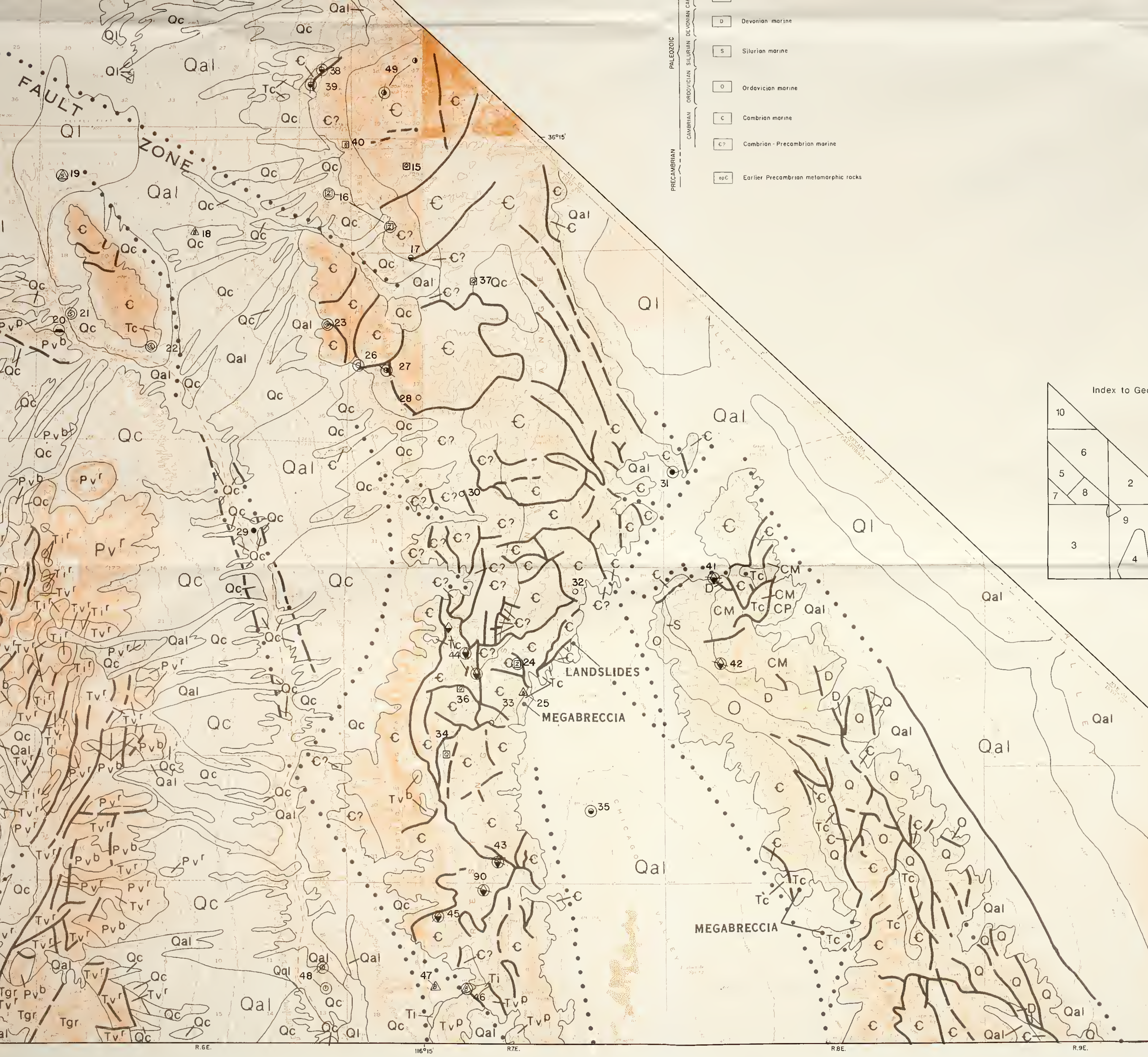
**Intrusive Rocks**

- $Tg^r$ — Tertiary granitic rocks
- Ti — Tertiary intrusive (hypabyssal) rocks: $Ti^r$-rhyolite; $Ti^a$-andesite; $Ti^b$-basalt
- bi — Mesozoic basic intrusive rocks

| | MINE NAME | LOCATION Township | Range | Section |
|---|---|---|---|---|
| 1. | Red Amphitheater | 26N | 3E | 17SW ¼ |
| 2. | Bentonite Placer Prospect | 26N | 4E | 17SW ¼ |
| 3. | Yellow Heart Prospect | 26N | 4E | 18SE ¼ |
| 4. | Deborah Prospect | 26N | 4E | 16NE ¼ |
| 5. | Kaolin Extension Prospect | 26N | 4E | 10SE ¼ |
| 6. | Kaolin Mine | 26N | 4E | 15NE ¼ |
| 7. | Kingfish No. 1 Prospect | 26N | 4E | 14NW ¼ |
| 8. | Kingfish No. 2 Prospect | 26N | 4E | 14SW ¼ |
| 9. | Vanderbilt Sidehill Mine | 26N | 5E | 18SW ¼ |
| | | | | 19NW ¼ |
| 10. | Blanco Prospect | 26N | 4E | 26NW ¼ |
| 11. | Unnamed Prospect | 26N | 4E | 27NE ¼ |
| 12. | Southeast Mineralized Zone | 26N | 4E | 34NW ¼ |
| 13. | Industrial Mineral Ventures Mine | 25,27N | 5E | 5,6,30,31 |
| 14. | Zeolites International Mine | 25N | 6E | 3,4,9,10,15,16,22 |
| 15. | Quartzite Occurrence | 25N | 7E | 29NW ¼ |
| 16. | Zeolite Occurrence | 25N | 7E | 31NE ¼ |
| | | 24N | 6E | 25,12 |
| 17. | Mineralized Zone | 24N | 7E | 5NW ¼ |
| 18. | East Eagle Mountain Prospects | 24N | 6E | 9,10.15,16 |
| 19. | North Eagle Mountain Prospects | 24N | 6E | 5,6,7,8 |
| 20. | Gold Junction Quarry | 24N | 6E | 19SW ¼ |
| 21. | Eagle Mountain Quarry | 24N | 6E | 19SE ¼ |
| 22. | Building Stone Quarry | 24N | 6E | 28NW ¼ |
| 23. | Unnamed Prospect | 24N | 6E | 24SE ¼ |
| 24. | Zeolite Occurrence | 23N | 7E | 10SW ¼ |
| 25. | Evaporite Occurrence | 23N | 7E | 15NW ¼ |
| 26. | Bonanza Prospect | 24N | 7E | 18NW ¼ |
| 27. | In Prospect | 24N | 7E | 18NE ¼ |
| 28. | Unnamed Prospect | 24N | 7E | 17SW ¼ |
| 29. | Arcan Prospect | 23N | 6E | 11SW ¼ |
| 30. | Unnamed Prospect | 24N | 7E | 28SW ¼ |
| 31. | SCP Prospect | 24N | 8E | 30 N ¼ |
| 32. | Unnamed Prospect | 23N | 7E | 2NW ¼ |
| 33. | Unnamed Prospect | 23N | 7E | 16SE ¼ |
| 34. | Quartzite Occurrence | 23N | 7E | 20SE ¼ |
| 35. | Unnamed Prospect | 23N | 7E | 26SE ¼ |
| 36. | Quartzite Occurrence | 23N | 7E | 16NE ¼ |
| 37. | Quartzite Occurrence | 24N | 7E | 4 W ¼ |
| 38. | Silver Tip Prospect | 25N | 6E | 25SW ¼ |
| 39. | Junior Prospect | 25N | 6E | 36NW ¼ |
| 40. | Unnamed Prospect | 24N | 6E | 1NE ¼ |
| 41. | Nancy-Ann Mine (Formerly Shaw Mine) | 23N | 8E | 6NE ¼ |
| 42. | Barnett Prospect | 23N | 8E | 8SW ¼ |
| 43. | High Chicago Group | 23N | 7E | 33,34 |
| | | 22N | 7E | 3 |
| 44. | Baxter Mine | 23N | 7E | 5,8,9,10,16,20 |
| 45. | Red Wing Mine | 22N | 7E | 5SE ¼ |
| 46. | Gerstley I Mine | 22N | 7E | 9SW ¼, 16NW ¼ |
| 47. | Gerstley II Deposit | 22N | 7E | 8 S ¼, 17 N ¼ |
| 48. | Unnamed Prospect | 22N | 6E | 12 S ¼ |
| 49. | Copper Hill Prospect | 25N | 7E | 18SE ¼, 17NW ¼ |
| 50. | Miller Spring Prospect | 22N | 5E | 4NE ¼ |
| 51. | Haefner Prospect | 23N | 5E | 23SW ¼ |
| 52. | Unnamed Prospect | 23N | 5E | 30SW ¼ |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlim Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |



Topographic Base Map from U.S. Geological Survey 15 minute Series




| | | | | |
|---|---|---|---|---|
| 52. | Unnamed Prospect | 23N | 5E | [illegible] |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlim Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |
| 61. | Pumice Occurrence | 24N | 4E | 33SE ¼ |
| 62. | Hidden Spring Prospect | 23N | 3E | 36NE ¼ |
| 63. | Bethome Shaft #1 | 24N | 3E | 35SW ¼ |
| 64. | Bethome Shaft #2 | 24N | 3E | 34SE ¼ |
| 65. | Funeral Range Copper Co. Shaft | 24N | 3E | 34SE ¼ |
| 66. | Greenwater Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 67. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 68. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 69. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 70. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 71. | Butte Furnace Range Shaft | 24N | 3E | 34NW ¼ |
| 72. | Pumice Occurrence | 24N | 4E | 17 E ½ |
| 73. | Lila C. Prospect | 24N | 4E | 12SE ¼ |
| 74. | Unnamed Prospect | 24N | 5E | 8NE ¼ |
| 75. | Lila C. Mine | 24N | 4E | 1SE ¼ |
| 76. | Maria Deposit | 25N | 4E | 34SE ¼ |
| 77. | U.S. Borax Cone Hill Claims | 25N | 4E | 32,33,28,29 |
| 78. | U.S. Borax Cone Hill Claims | 25N | 4E | 31 |
| 79. | Zeolite Occurrence | 25N | 4E | 20 S ½ |
| 80. | Terry Mine | 25N | 4E | 21SE ¼ |
| 81. | Smith Prospect | 24N | 5E | 4NW ¼ |
| 82. | Widow No. 3 Mine | 25N | 3E | 16SW ¼ |
| 83. | Widow No. 7 Mine | 25N | 3E | 16SW ¼ |
| 84. | Lizzie V. Oakley Mine | 25N | 3E | 17SE ¼ |
| 85. | Grand View Mine | 25N | 3E | 17SE ¼ |
| 86. | Upper Biddy McCarthy Mine | 25N | 3E | 8 E ½ |
| 87. | Lower Biddy McCarthy Mine | 25N | 3E | 8 E ½ |
| 88. | Played Out Mine | 25N | 3E | 4 N ½ |
| 89. | Billie Mine | 26N | 3E | 31 S ½, 6NW ¼ |
| 90. | Unnamed Prospect | 22N | 7E | 4NE ¼ |

Index to Geologic Mapping

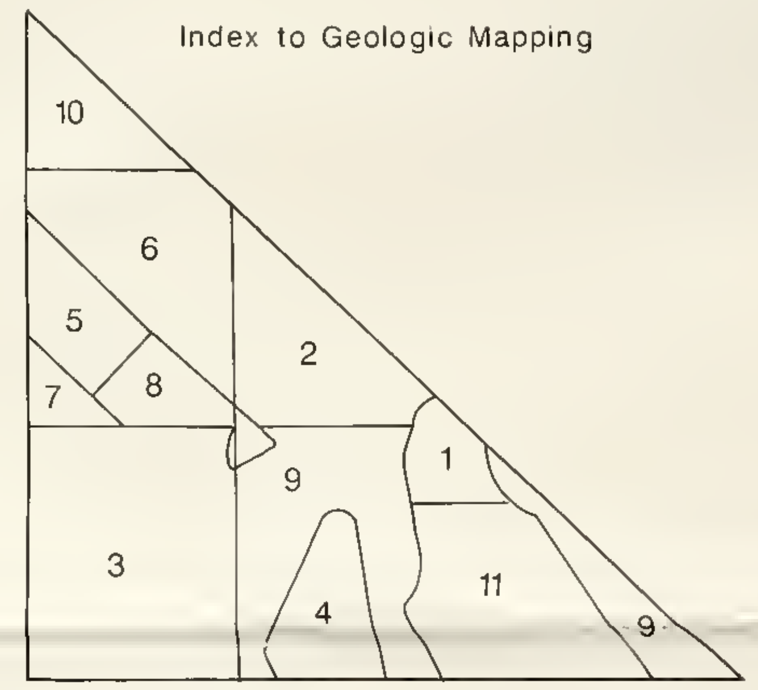




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PLATE 2

# MINERAL LAND CLASSIFICATION MAP

## ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP & STEWART VALLEY 15-MINUTE QUADRANGLES AND HIGH PEAK 7 1/2-MINUTE QUADRANGLE

Compiled by
GARY C. TAYLOR

1986

SCALE 1:62,500

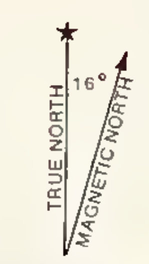
CONTOUR INTERVAL 80 FEET

### MINERAL DEPOSIT SYMBOLS

**METALLIC**
- Gold, Placer
- Gold, Lode
- Copper
- Lead, Silver, Zinc

**NON-METALLIC**
- Clay
- Silica/Quartzite (si)
- Zeolite
- Borate
- Pumice
- Stone

- Field visited
- Mine Index Number
- Orientation of Deposit



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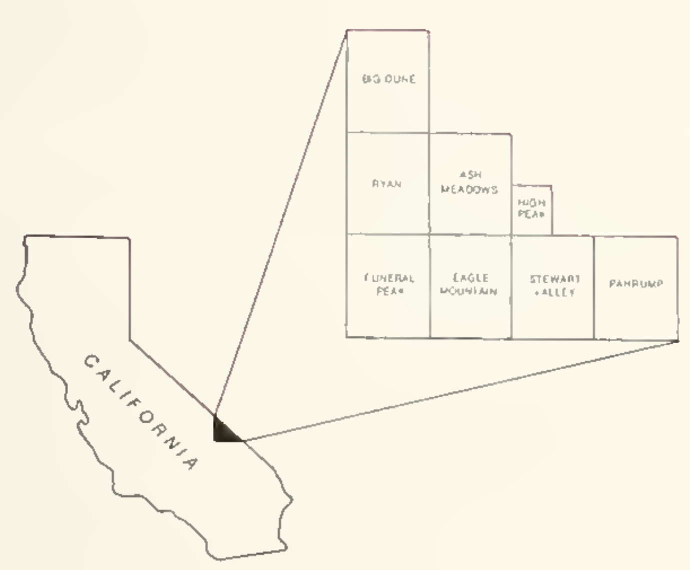
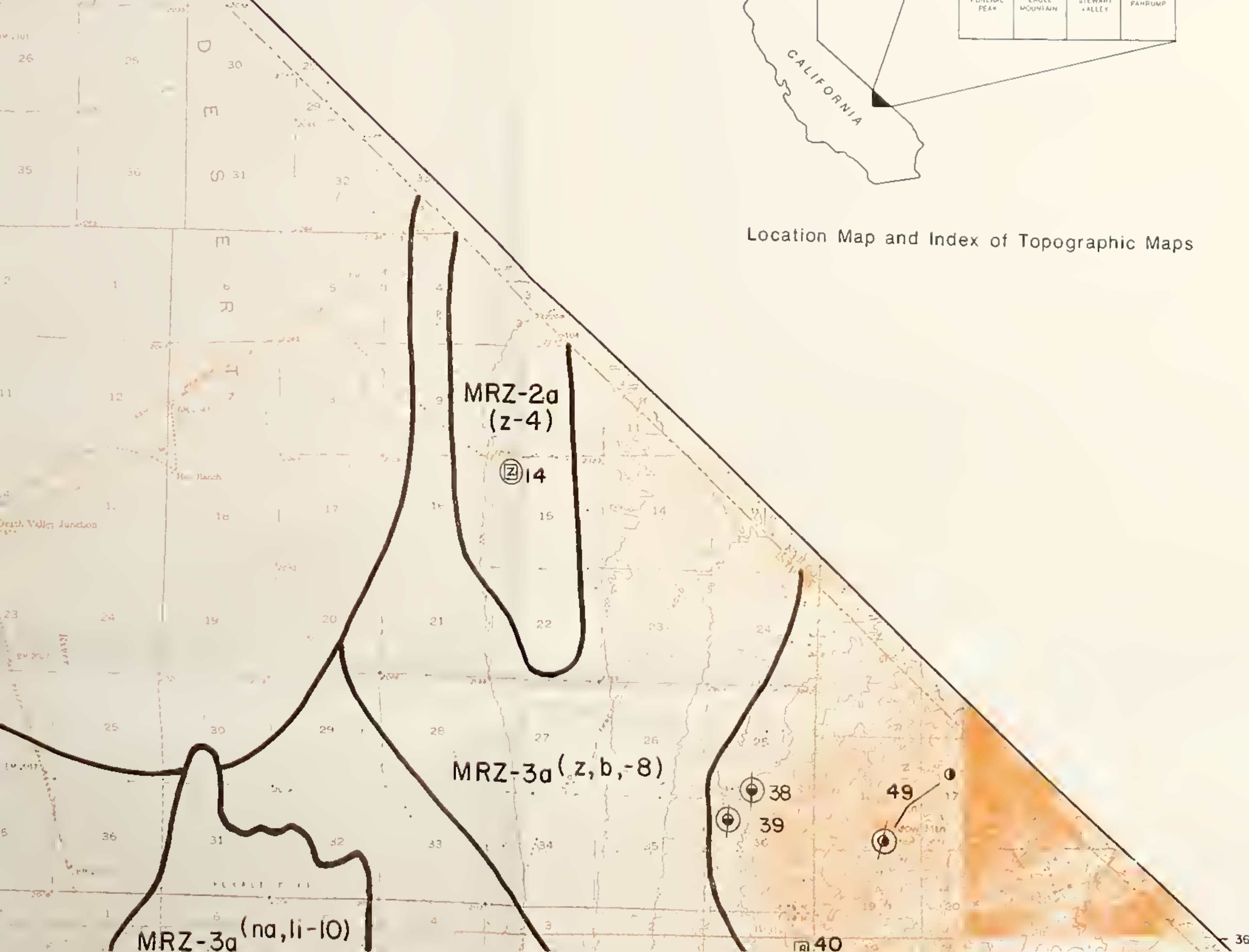


Location Map and Index of Topographic Maps




### AREAS CLASSIFIED FOR INDUSTRIAL MINERAL DEPOSITS–

### BARITE, BENTONITE, CARBONATE ROCK, HECTORITE, PERLITE, PUMICE, SALINES, SILICA/QUARTZITE, STONE, ZEOLITE

### PLATE 2

Industrial Mineral Deposits

MRZ-1(i): Areas where available geologic information indicates there is little likelihood for the presence of industrial mineral deposits.

MRZ-2a(i): Areas where geologic data indicates that significant measured or indicated industrial mineral reserves are present.

MRZ-2b(i): Areas underlain by deposits containing industrial minerals where geologic information indicates significant inferred resources of rock suitable for use as a marketable product are present.

MRZ-3a(i): Areas underlain by geologic terranes within which undiscovered industrial mineral resources similar to known deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Such areas may include prospects of undetermined significance.

MRZ-3b(i): Areas that may contain undiscovered industrial mineral resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of depsits as yet unrecognized for their economic potential.

MRZ-4(i): Areas where geologic information does not rule out either the presence or absence of industrial mineral resources.

| | MINE NAME | LOCATION Township | Range | Section |
|---|---|---|---|---|
| 1. | Red Amphitheater | 26N | 3E | 17SW ¼ |
| 2. | Bentonite Placer Prospect | 26N | 4E | 17SW ¼ |
| 3. | Yellow Heart Prospect | 26N | 4E | 18SE ¼ |
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| 7. | Kingfish No. 1 Prospect | 26N | 4E | 14NW ¼ |
| 8. | Kingfish No. 2 Prospect | 26N | 4E | 14SW ¼ |
| 9. | Vanderbilt Sidehill Mine | 26N | 5E | 18SW ¼ |
| | | | | 19NW ¼ |
| 10. | Blanco Prospect | 26N | 4E | 26NW ¼ |
| 11. | Unnamed Prospect | 26N | 4E | 27NE ¼ |
| 12. | Southeast Mineralized Zone | 26N | 4E | 34NW ¼ |
| 13. | Industrial Mineral Ventures Mine | 25,27N | 5E | 5,6,30,31 |
| 14. | Zeolites International Mine | 25N | 6E | 3,4,9,10,15,16,22 |
| 15. | Quartzite Occurrence | 25N | 7E | 29NW ¼ |
| 16. | Zeolite Occurrence | 25N | 7E | 31NE ¼ |
| | | 24N | 6E | 25,12 |
| 17. | Mineralized Zone | 24N | 7E | 5NW ¼ |
| 18. | East Eagle Mountain Prospects | 24N | 6E | 9,10.15,16 |
| 19. | North Eagle Mountain Prospects | 24N | 6E | 5,6,7,8 |
| 20. | Gold Junction Quarry | 24N | 6E | 19SW ¼ |
| 21. | Eagle Mountain Quarry | 24N | 6E | 19SE ¼ |
| 22. | Building Stone Quarry | 24N | 6E | 28NW ¼ |
| 23. | Unnamed Prospect | 24N | 6E | 24SE ¼ |
| 24. | Zeolite Occurrence | 23N | 7E | 10SW ¼ |
| 25. | Evaporite Occurrence | 23N | 7E | 15NW ¼ |
| 26. | Bonanza Prospect | 24N | 7E | 18NW ¼ |
| 27. | In Prospect | 24N | 7E | 18NE ¼ |
| 28. | Unnamed Prospect | 24N | 7E | 17SW ¼ |
| 29. | Arcan Prospect | 23N | 6E | 11SW ¼ |
| 30. | Unnamed Prospect | 24N | 7E | 28SW ¼ |
| 31. | SCP Prospect | 24N | 8E | 30 N ¼ |
| 32. | Unnamed Prospect | 23N | 7E | 2NW ¼ |
| 33. | Unnamed Prospect | 23N | 7E | 16SE ¼ |
| 34. | Quartzite Occurrence | 23N | 7E | 20SE ¼ |
| 35. | Unnamed Prospect | 23N | 7E | 26SE ¼ |
| 36. | Quartzite Occurrence | 23N | 7E | 16NE ¼ |
| 37. | Quartzite Occurrence | 24N | 7E | 4 W ¼ |
| 38. | Silver Tip Prospect | 25N | 6E | 25SW ¼ |
| 39. | Junior Prospect | 25N | 6E | 36NW ¼ |
| 40. | Unnamed Prospect | 24N | 6E | 1NE ¼ |
| 41. | Nancy-Ann Mine (Formerly Shaw Mine) | 23N | 8E | 6NE ¼ |
| 42. | Barnett Prospect | 23N | 8E | 8SW ¼ |
| 43. | High Chicago Group | 23N | 7E | 33,34 |
| | | 22N | 7E | 3 |
| 44. | Baxter Mine | 23N | 7E | 5,8,9,10,16,20 |
| 45. | Red Wing Mine | 22N | 7E | 5SE ¼ |
| 46. | Gerstley I Mine | 22N | 7E | 9SW ¼, 16NW ¼ |
| 47. | Gerstley II Deposit | 22N | 7E | 8 S ¼, 17 N ¼ |
| 48. | Unnamed Prospect | 22N | 6E | 12 S ¼ |
| 49. | Copper Hill Prospect | 25N | 7E | 18SE ¼, 17NW ¼ |
| 50. | Miller Spring Prospect | 22N | 5E | 4NE ¼ |
| 51. | Haefner Prospect | 23N | 5E | 23SW ¼ |
| 52. | Unnamed Prospect | 23N | 5E | 30SW ¼ |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlim Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |
| 61. | Pumice Occurrence | 24N | 4E | 33SE ¼ |
| 62. | Hidden Spring Prospect | 23N | 3E | 36NE ¼ |
| 63. | Bethome Shaft #1 | 24N | 3E | 35SW ¼ |
| 64. | Bethome Shaft #2 | 24N | 3E | 34SE ¼ |
| 65. | Funeral Range Copper Co. Shaft | 24N | 3E | 34SE ¼ |
| 66. | Greenwater Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 67. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 68. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |

MRZ-3a (z-12)
MRZ-2b (bo-7)
MRZ-2a (bo-3)
MRZ-3b (bo-16)
MRZ-3a (na, li-10)
MRZ-3a (z, b, -8)
MRZ-4
MRZ-3b (p-20)
MRZ-3a (pu-15)
MRZ-3a (s-14)
MRZ-3a (ba-13)
MRZ-3b (ba-22)
MRZ-3b (bo-16)
MRZ-3b (p-20)
MRZ-3b (z, pu-21)
MRZ-4
MRZ-4
MRZ-4
D E A T H V A L L E Y
N A T I O N A L
M O N U M E N T
T. 25N.
T. 24N.
T. 23N.
T. 22.5N.
T. 22N.
36°15'
36°00'
116°45'
R.2E.
R.3E.
116°30'
R.5E.
R.6E.
116°15'
Topographic Base Map from U.S. Geological Survey 15 minute Series.

MRZ-3a: Areas underlain by geologic terranes within which undiscovered industrial mineral resources similar to known deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Such areas may include prospects of undetermined significance.

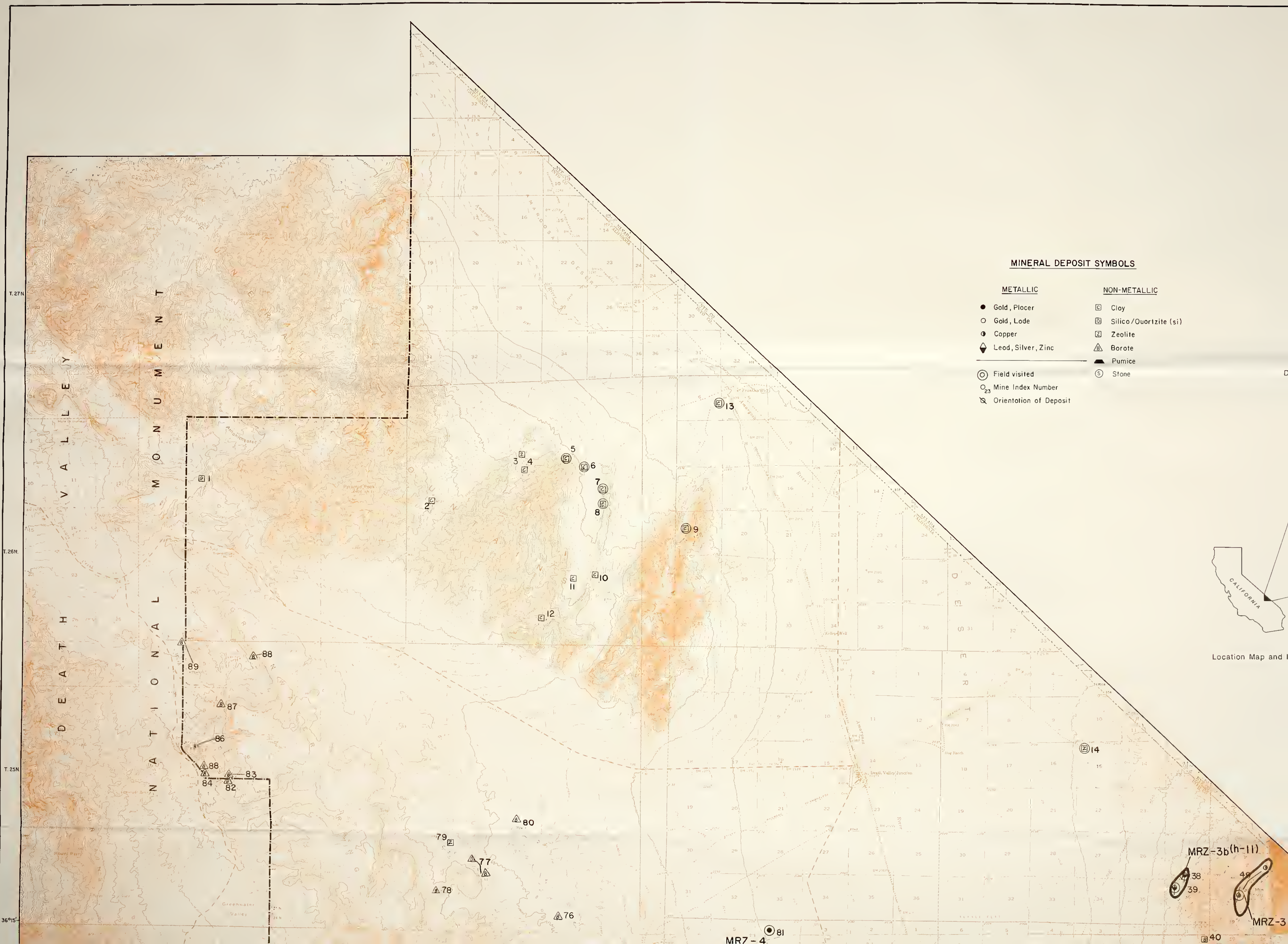
MRZ-3b(i): Areas that may contain undiscovered industrial mineral resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of depsits as yet unrecognized for their economic potential.

MRZ-4(i): Areas where geologic information does not rule out either the presence or absence of industrial mineral resources.

| | | | | |
|---|---|---|---|---|
| 4B. | Unnamed Prospect | 22N | 6E | 12 S ¼ |
| 49. | Copper Hill Prospect | 25N | 7E | 18SE ¼, 17NW ¼ |
| 50. | Miller Spring Prospect | 22N | 5E | 4NE ¼ |
| 51. | Haefner Prospect | 23N | 5E | 23SW ¼ |
| 52. | Unnamed Prospect | 23N | 5E | 30SW ¼ |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlim Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |
| 61. | Pumice Occurrence | 24N | 4E | 33SE ¼ |
| 62. | Hidden Spring Prospect | 23N | 3E | 36NE ¼ |
| 63. | Bethome Shaft #1 | 24N | 3E | 35SW ¼ |
| 64. | Bethome Shaft #2 | 24N | 3E | 34SE ¼ |
| 65. | Funeral Range Copper Co. Shaft | 24N | 3E | 34SE ¼ |
| 66. | Greenwater Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 67. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 68. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 69. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 70. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 71. | Butte Furnace Range Shaft | 24N | 3E | 34NW ¼ |
| 72. | Pumice Occurrence | 24N | 4E | 17 E ¼ |
| 73. | Lila C. Prospect | 24N | 4E | 12SE ¼ |
| 74. | Unnamed Prospect | 24N | 5E | BNE ¼ |
| 75. | Lila C. Mine | 24N | 4E | 1SE ¼ |
| 76. | Maria Deposit | 25N | 4E | 34SE ¼ |
| 77. | U.S. Borax Cone Hill Claims | 25N | 4E | 32,33,28,29 |
| 78. | U.S. Borax Cone Hill Claims | 25N | 4E | 31 |
| 79. | Zeolite Occurrence | 25N | 4E | 20 S ¼ |
| 80. | Terry Mine | 25N | 4E | 21SE ¼ |
| 81. | Smith Prospect | 24N | 5E | 4NW ¼ |
| 82. | Widow No. 3 Mine | 25N | 3E | 16SW ¼ |
| 83. | Widow No. 7 Mine | 25N | 3E | 16SW ¼ |
| 84. | Lizzie V. Oakley Mine | 25N | 3E | 17SE ¼ |
| 85. | Grand View Mine | 25N | 3E | 17SE ¼ |
| 86. | Upper Biddy McCarthy Mine | 25N | 3E | 8 E ¼ |
| 87. | Lower Biddy McCarthy Mine | 25N | 3E | 8 E ¼ |
| 88. | Played Out Mine | 25N | 3E | 4 N ¼ |
| 89. | Billie Mine | 26N | 3E | 31 S ¼, 6NW ¼ |
| 90. | Unnamed Prospect | 22N | 7E | 4NE ¼ |

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-PETE WILSON, GOVERNOR
THE RESOURCES AGENCY-DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-EDWARD G. HEIDIG, DIRECTOR



STATE OF CALIFORNIA-PETE WILSON, GOVERNOR
THE RESOURCES AGENCY-DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-EDWARD G. HEIDIG, DIRECTOR



# MINERAL LAND CLASSIFICATION MAP

## ASH MEADOWS, BIG DUNE, EAGLE MOUNTAIN, FUNERAL PEAK, RYAN, PAHRUMP & STEWART VALLEY 15-MINUTE QUADRANGLES

## AND

## HIGH PEAK 7 1/2-MINUTE QUADRANGLE

Compiled by

GARY C. TAYLOR

1986

SCALE 1:62,500

CONTOUR INTERVAL 80 FEET

### MINERAL DEPOSIT SYMBOLS

METALLIC

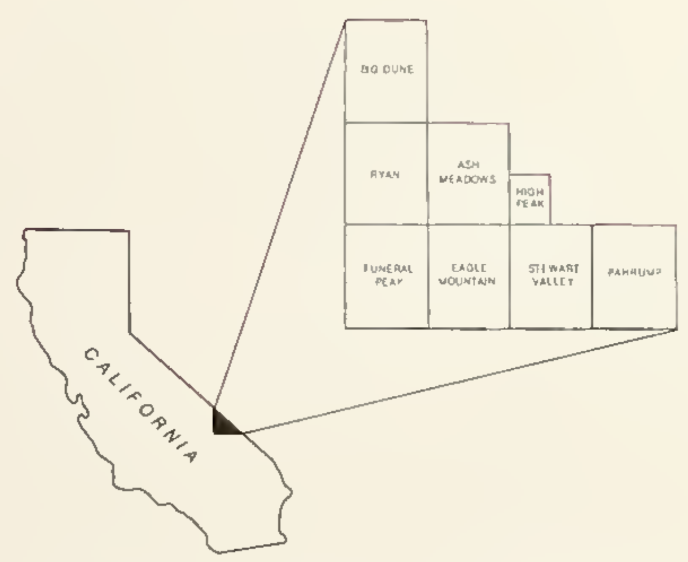
- Gold, Placer
- Gold, Lode
- Copper
- Lead, Silver, Zinc

NON-METALLIC

- Clay
- Silica/Quartzite (si)
- Zeolite
- Borate
- Pumice
- Stone

- Field visited
- Mine Index Number
- Orientation of Deposit


DECLINATION




Location Map and Index of Topographic Maps

### AREAS CLASSIFIED FOR HYDROTHERMAL MINERAL DEPOSITS

Au, Ag, Cu, Pb, Zn

### PLATE 3

Mineral Deposits Formed by Hydrothermal Processes
(Gold, Copper, Lead, Silver, Zinc)

MRZ-1$^{(h)}$: Areas where geologic information indicates there Is little likelihood that hydrothermal mineral deposits of significance are present.

MRZ-2a$^{(h)}$: Areas containing hydrothermal ore deposits where geologic data indicates that significant measured or indicated reserves are present.

MRZ-2b$^{(h)}$: Areas containing hydrothermal ore deposits where geologic information indicates that significant inferred resources are present.

MRZ-3a$^{(h)}$: Areas underlain by geologic terranes within which undiscovered metallic deposits similar to known hydrothermal deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Such areas may include prospects of undetermined significance.

MRZ-3b$^{(h)}$: Areas that may contain undiscovered metallic resources of hydrothermal origin that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized

| | MINE NAME | LOCATION Township | Range | Section |
|---|---|---|---|---|
| 1. | Red Amphitheater | 26N | 3E | 17SW ¼ |
| 2. | Bentonite Placer Prospect | 26N | 4E | 17SW ¼ |
| 3. | Yellow Heart Prospect | 26N | 4E | 18SE ¼ |
| 4. | Deborah Prospect | 26N | 4E | 16NE ¼ |
| 5. | Kaolin Extension Prospect | 26N | 4E | 10SE ¼ |
| 6. | Kaolin Mine | 26N | 4E | 15NE ¼ |
| 7. | Kingfish No. 1 Prospect | 26N | 4E | 14NW ¼ |
| 8. | Kingfish No. 2 Prospect | 26N | 4E | 14SW ¼ |
| 9. | Vanderbilt Sidehill Mine | 26N | 5E | 18SW ¼ |
| | | | | 19NW ¼ |
| 10. | Blanco Prospect | 26N | 4E | 26NW ¼ |
| 11. | Unnamed Prospect | 26N | 4E | 27NE ¼ |
| 12. | Southeast Mineralized Zone | 26N | 4E | 34NW ¼ |
| 13. | Industrial Mineral Ventures Mine | 25,27N | 5E | 5,6,30,31 |
| 14. | Zeolites International Mine | 25N | 6E | 3,4,9,10,15,16,22 |
| 15. | Quartzite Occurrence | 25N | 7E | 29NW ¼ |
| 16. | Zeolite Occurrence | 25N | 7E | 31NE ¼ |
| | | 24N | 6E | 25,12 |
| 17. | Mineralized Zone | 24N | 7E | 5NW ¼ |
| 18. | East Eagle Mountain Prospects | 24N | 6E | 9,10.15,16 |
| 19. | North Eagle Mountain Prospects | 24N | 6E | 5,6,7,8 |
| 20. | Gold Junction Quarry | 24N | 6E | 19SW ¼ |
| 21. | Eagle Mountain Quarry | 24N | 6E | 19SE ¼ |
| 22. | Building Stone Quarry | 24N | 6E | 28NW ¼ |
| 23. | Unnamed Prospect | 24N | 6E | 24SE ¼ |
| 24. | Zeolite Occurrence | 23N | 7E | 10SW ¼ |
| 25. | Evaporite Occurrence | 23N | 7E | 15NW ¼ |
| 26. | Bonanza Prospect | 24N | 7E | 18NW ¼ |
| 27. | In Prospect | 24N | 7E | 18NE ¼ |
| 28. | Unnamed Prospect | 24N | 7E | 17SW ¼ |
| 29. | Arcan Prospect | 23N | 6E | 11SW ¼ |
| 30. | Unnamed Prospect | 24N | 7E | 28SW ¼ |
| 31. | SCP Prospect | 24N | 8E | 30 N ¼ |
| 32. | Unnamed Prospect | 23N | 7E | 2NW ¼ |
| 33. | Unnamed Prospect | 23N | 7E | 16SE ¼ |
| 34. | Quartzite Occurrence | 23N | 7E | 20SE ¼ |
| 35. | Unnamed Prospect | 23N | 7E | 26SE ¼ |
| 36. | Quartzite Occurrence | 23N | 7E | 16NE ¼ |
| 37. | Quartzite Occurrence | 24N | 7E | 4 W ¼ |
| 38. | Silver Tip Prospect | 25N | 6E | 25SW ¼ |
| 39. | Junior Prospect | 25N | 6E | 36NW ¼ |
| 40. | Unnamed Prospect | 24N | 6E | 1NE ¼ |
| 41. | Nancy-Ann Mine (Formerly Shaw Mine) | 23N | 8E | 6NE ¼ |
| 42. | Barnett Prospect | 23N | 8E | 8SW ¼ |
| 43. | High Chicago Group | 23N | 7E | 33,34 |
| | | 22N | 7E | 3 |
| 44. | Baxter Mine | 23N | 7E | 5,8,9,10,16,20 |
| 45. | Red Wing Mine | 22N | 7E | 5SE ¼ |
| 46. | Gerstley I Mine | 22N | 7E | 9SW ¼, 16NW ¼ |
| 47. | Gerstley II Deposit | 22N | 7E | 8 S ¼, 17 N ¼ |
| 48. | Unnamed Prospect | 22N | 6E | 12 S ¼ |
| 49. | Copper Hill Prospect | 25N | 7E | 18SE ¼, 17NW ¼ |
| 50. | Miller Spring Prospect | 22N | 5E | 4NE ¼ |
| 51. | Haefner Prospect | 23N | 5E | 23SW ¼ |
| 52. | Unnamed Prospect | 23N | 5E | 30SW ¼ |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlin Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |
| 61. | Pumice Occurrence | 24N | 4E | 33SE ¼ |
| 62. | Hidden Spring Prospect | 23N | 3E | 36NE ¼ |
| 63. | Bethome Shaft #1 | 24N | 3E | 35SW ¼ |
| 64. | Bethome Shaft #2 | 24N | 3E | 34SE ¼ |
| 65. | Funeral Range Copper Co. Shaft | 24N | 3E | 34SE ¼ |

MRZ-3b(h-11)
MRZ-3b
MRZ-4
MRZ-3b(h-12)
MRZ-3a (h-1)
DEATH VALLEY
NATIONAL
MONUMENT
MRZ-3b (h-7)
MRZ-3a (h-2)
MRZ-3a (h-2)
MRZ-3a (h-3)
MRZ-3b (h-7)
MRZ-3a (h-6)
MRZ-3a (h-2)
T. 25N.
T. 24N.
T. 23N.
T. 22.5N.
T. 22N.
36°15'
36°00'
116°45'
R.2E.
R.3E.
116°30'
R.5E.
R.6E.
116°15'
Topographic Base Map from U.S. Geological Survey 15-minute Series.

present.

MRZ-2b(h): Areas containing hydrothermal ore deposits where geologic information indicates that significant inferred resources are present.

MRZ-3a(h): Areas underlain by geologic terranes within which undiscovered metallic deposits similar to known hydrothermal deposits in the same producing district or region may be reasonably expected to exist (hypothetical resources). Such areas may include prospects of undetermined significance.

MRZ-3b(h): Areas that may contain undiscovered metallic resources of hydrothermal origin that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their mineral potential (speculative resources).

MRZ-4(h): Areas where available information does not rule out the presence or absence of hydrothermal mineral deposits.

| | | | | |
|---|---|---|---|---|
| 43. | High Chicago Group | 23N | 7E | 33,34 |
| | | 22N | 7E | 3 |
| 44. | Baxter Mine | 23N | 7E | 5,8,9,10,16,20 |
| 45. | Red Wing Mine | 22N | 7E | 5SE ¼ |
| 46. | Gerstley I Mine | 22N | 7E | 9SW ¼, 16NW ¼ |
| 47. | Gerstley II Deposit | 22N | 7E | 8 S ½, 17 N ½ |
| 48. | Unnamed Prospect | 22N | 6E | 12 S ½ |
| 49. | Copper Hill Prospect | 25N | 7E | 18SE ¼, 17NW ¼ |
| 50. | Miller Spring Prospect | 22N | 5E | 4NE ¼ |
| 51. | Haefner Prospect | 23N | 5E | 23SW ¼ |
| 52. | Unnamed Prospect | 23N | 5E | 30SW ¼ |
| 53. | Unnamed Prospect | 23N | 5E | 30NW ¼ |
| 54. | Unnamed Prospect | 23N | 4E | 36NW ¼ |
| 55. | Unnamed Prospect | 22½N | 4E | 25NW ¼ |
| 56. | Green Gremlim Prospect | 23N | 4E | 21NE ¼ |
| 57. | Unnamed Prospect | 23N | 4E | 16NW ¼ |
| 58. | Canyon Portal Prospect | 23N | 4E | 9NW ¼ |
| 59. | Unnamed Prospect | 23N | 4E | 6NW ¼ |
| 60. | Unnamed Prospect | 24N | 4E | 32SW ¼ |
| 61. | Pumice Occurrence | 24N | 4E | 33SE ¼ |
| 62. | Hidden Spring Prospect | 23N | 3E | 36NE ¼ |
| 63. | Bethome Shaft #1 | 24N | 3E | 35SW ¼ |
| 64. | Bethome Shaft #2 | 24N | 3E | 34SE ¼ |
| 65. | Funeral Range Copper Co. Shaft | 24N | 3E | 34SE ¼ |
| 66. | Greenwater Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 67. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NE ¼ |
| 68. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 69. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 70. | Furnace Creek Copper Co. Shaft | 24N | 3E | 34NW ¼ |
| 71. | Butte Furnace Range Shaft | 24N | 3E | 34NW ¼ |
| 72. | Pumice Occurrence | 24N | 4E | 17 E ½ |
| 73. | Lila C. Prospect | 24N | 4E | 12SE ¼ |
| 74. | Unnamed Prospect | 24N | 5E | 8NE ¼ |
| 75. | Lila C. Mine | 24N | 4E | 1SE ¼ |
| 76. | Maria Deposit | 25N | 4E | 34SE ¼ |
| 77. | U.S. Borax Cone Hill Claims | 25N | 4E | 32,33,28,29 |
| 78. | U.S. Borax Cone Hill Claims | 25N | 4E | 31 |
| 79. | Zeolite Occurrence | 25N | 4E | 20 S ½ |
| 80. | Terry Mine | 25N | 4E | 21SE ¼ |
| 81. | Smith Prospect | 24N | 5E | 4NW ¼ |
| 82. | Widow No. 3 Mine | 25N | 3E | 16SW ¼ |
| 83. | Widow No. 7 Mine | 25N | 3E | 16SW ¼ |
| 84. | Lizzie V. Oakley Mine | 25N | 3E | 17SE ¼ |
| 85. | Grand View Mine | 25N | 3E | 17SE ¼ |
| 86. | Upper Biddy McCarthy Mine | 25N | 3E | 8 E ½ |
| 87. | Lower Biddy McCarthy Mine | 25N | 3E | 8 E ½ |
| 88. | Played Out Mine | 25N | 3E | 4 N ½ |
| 89. | Billie Mine | 26N | 3E | 31 S ½, 6NW ¼ |
| 90. | Unnamed Prospect | 22N | 7E | 4NE ¼ |